VOLUMETRIC SURVEY OF WELSH RESERVOIR

Prepared for:
AEP/Southwestern Electric Power Company

In cooperation with the
Northeast Texas Municipal Water District

Prepared by
Texas Water Development Board

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INTRODUCTION

Staff of the Surface Water Section of the Texas Water Development Board (TWDB) conducted a volumetric survey of Welsh Reservoir on November 27 and 28, 2001. The primary purpose of this survey was to determine the current volume of the reservoir at conservation pool elevation. Results from this survey will serve as a basis for comparison to future surveys to allow the location and rates of sediment deposition to be determined. Survey results are presented in the following pages in both graphical and tabular form.

The vertical datum used during this survey is based on the reservoir gauge that is maintained by the American Electric Power/Southwestern Electric Power Company who operates the reservoir and electric power-generating plant. The datum for this gauge is reported at mean sea level (msl). Thus, elevations are reported here in feet (ft) above mean sea level (msl). Volume and area calculations in this report are referenced to water levels provided by the reservoir gauge.

According to the original design information, the surface area was 1,365 acres at conservation pool elevation 320.0 ft; the total storage volume was estimated to be 23,587 acre-feet (ac-ft) of water (Camp Dresser & McKee Consulting Engineers, Phase I Inspection Report National Dam Safety Program, 1979). This report will compare the 2001 survey results with the original design information developed in 1974.

RESERVOIR HISTORY AND GENERAL INFORMATION

Welsh Reservoir and associated Welsh Dam (formerly Swauano Creek Dam) is located on Swauano Creek (Cypress River Basin) in Titus County, approximately 12 miles southeast of Mt. Pleasant, Texas (Figure 1). At conservation pool elevation (320.0 ft), the reservoir extends approximately 5 miles upstream on Swauano Creek. Records indicate the drainage area is approximately 21.75 square miles. At conservation pool elevation the reservoir has approximately 25 miles of shoreline. Welsh Reservoir and Dam were designed for industrial and recreational use.

American Electric Power /Southwestern Electric Power Company (AEP/SWEPCO) owns the water rights to Welsh Reservoir. AEP/SWEPCO also owns and maintains the dam and appurtenant structures. All releases from the reservoir and other water-related operations are under the control of AEP/SWEPCO.

The Texas Water Rights Commission granted Water Rights Permit No. 2926 (Application No. 3164) to Southwestern Electric Power Company (SWEPCO) on May 30, 1974. The permit allowed SWEPCO "to construct a dam and reservoir on Swauano Creek in Titus County and impound therein not to exceed 23,587 ac-ft of water." SWEPCO was authorized to divert, circulate and recirculate, and to consumptively use not to exceed 11,000 ac-ft from the reservoir. The right to use the impounded waters for recreation purposes was also granted.

AEP/SWEPCO's current authorization is based on Certificate of Adjudication # 04-4576 issued by the Texas Water Commission on October 13, 1986. The certificate authorizes SWEPCO to maintain an existing dam and reservoir (Welsh Reservoir) on Swauano Creek and impound therein not to exceed 23,587 ac-ft of water.

The owner of the certificate is authorized to divert, ciculate, recirculate and use consumptively not to exceed 11,000 ac-ft of water per annum for industrial purposes.

The owner is also authorized to use the impounded water in the reservoir for recreational purposes.

Copies of the Permits and Certificate of Adjudication (original and amended) may be obtained from the Texas Natural Resource Conservation Commission's Central Records in Austin, Texas.

Construction for the Welsh Reservoir Project started June 24,1974 and was completed September 25,1975. Deliberate impoundment of water began September 29,1975 (Freese and Nichols Inc. Consulting Engineers, Safety Inspection of Swauano Creek Dam at Welsh Power Plant, September 1989). Freese and Nichols Inc. Consulting Engineers was the design engineer and the construction contractor was List & Clark Construction Company of Overland Park, Kansas (Camp, Dresser & McKee, Inc., 1979).

Engineering designs (Camp, Dresser & McKee, Inc., 1979) show Welsh Dam and appurtenant structures to consist of an earth fill embankment, approximately 4,800 ft in length with a maximum height of 60 ft and a crest elevation of 335.0 ft. The upstream slope of the embankment is protected by a soil-cement for erosion control.

The service spillway is an uncontrolled reinforced concrete morning glory structure and is located near the left (east) end of the embankment. Discharges pass through the embankment downstream via a 7-ft wide by 8-ft tall box conduit. The crest elevation of the morning glory is 320.0 ft.

The emergency spillway is a 1,500-ft wide trapezoidal shape earth cut channel located at the right (west) end of the embankment. The crest elevation of the emergency spillway is 326.0 ft.

The outlet works or regulating outlet consists of an 18-inch pipe connected to the service spillway discharge conduit. The invert elevation of the 18-inch pipe is 295.0 ft. Dual valves control releases.

SURVEYING EQUIPMENT

The equipment used to perform the volumetric survey consists of a 20-foot aluminum shallow-draft flat bottom SeaArk craft with cabin and equipped with one 115-horsepower Evinrude outboard motor. The portable data collection equipment on-board the boat included a Knudsen 320 B/P Echosounder (depth sounder), a Trimble Navigation, Inc. Ag132 GPS receiver with OmniSTAR (for differential corrections) and a laptop PC.

The GPS equipment, survey vessel, and depth sounder in combination provide an efficient hydrographic survey system. As the boat travels across the reservoir's surface, the depth sounder takes approximately ten readings of the reservoir's bottom each second. The depth readings are stored on the survey vessel's on-board computer along with the corrected positional data generated by the boat's GPS receiver. The data files collected are downloaded from the computer and brought to the office for editing after the survey is completed. During editing, poor-quality data is removed or corrected, multiple data points are averaged to get one data point per second, and average depths are converted to elevation readings based on the reservoir's elevation, recorded on the day the survey was performed. Accurate estimates of the reservoir's volume can be determined by building a 3-D model of the reservoir from the collected data.

PRE-SURVEY PROCEDURES

The reservoir's boundary was digitized using Environmental Systems Research Institute's (ESRI) Arcview from digital orthophoto quadrangle images (DOQ's). The DOQ's were produced by VARGIS of Texas LLC for the TEXAS Orthoimagery Program (TOP). The DOQ products produced for the Department of Information Resources and the GIS Planning Council under the Texas Orthoimagery Program reside in the public domain. More information can be obtained on the Internet at http://www.tnris.state.tx.us/DigitalData/doqs.htm. The map boundary was created from

the CASON, TEXAS DOQs and Digital Raster Graphics (DRG's) which are digital versions of 7.5-minute topographical maps. The reservoir's elevation at the time the DOQs were photographed was 320.17 ft on March 09,1995 and 317.20 on January 6, 1996. The DRG was photo-revised in 1980. The boundary was completed by overlaying the survey data points and comparing to the above digital maps making sure that all survey data were within the boundary and using the DRG to compensate for the low water level in the January 6, 1996 photo.

The DOQ and DRG graphic boundary files were transformed from UTM Zone 14 datum to NAD '83, using Environmental Systems Research Institute's (ESRI) Arc/Info PROJECT command with the NADCOM (standard conversion method within the United States) parameters.

The survey layout was designed by placing survey track lines at 500-foot intervals within the digitized reservoir's boundary using Coastal Oceanographics' HYPACK software. The survey design required the use of approximately 90 survey lines along the length of the reservoir and perpendicular to the original creek channels.

SURVEY PROCEDURES

Equipment Calibration and Operation

At the beginning of each day of the survey, the depth sounder is calibrated using the bar check feature in the Knudsen software program. This is accomplished by positioning the transducer over a known (measured) depth. The value for the speed of sound is adjusted in the software (either higher or lower) until the displayed depths matched the known depth. The depth is then checked manually with a stadia (survey) rod to ensure that the depth sounder is properly calibrated and operating correctly.

While surveying Welsh Reservoir, the speed of sound in the water column was 4,750 feet per second. Based on the measured speed of sound for various depths and the average speed of sound calculated for the entire water column, the depth sounder is accurate to within ±0.2 feet. An additional estimated error of ±0.3 feet arises from variation in boat inclination. These two factors combine to give an overall accuracy of ±0.5 feet for any instantaneous reading. These errors tend to be minimized over the entire survey, since some readings are positive and some are negative. Further information on these calculations is presented in Appendix G.

During the survey, the horizontal mask setting on the on-board GPS receiver was set to 10 degrees and the PDOP (Position Dilution of Precision) limit was set to 7 to maximize the accuracy of the horizontal positioning. An internal alarm sounds if PDOP rises above seven to advise the field crew that the horizontal position has degraded to an unacceptable level. The lake's initialization file used by the HYPACK data collection program was set up to convert the collected DGPS positions to state-plane coordinates on the fly.

Field Survey

TWDB staff collected data at Welsh Reservoir on November 27 and 28, 2001. The lake-level elevation remained constant at 319.9 ft. The weather and surface water conditions were excellent for the first day of data collection. A northern cold front blew in early on the second day of the survey. Strong thunderstorms and high winds delayed the data collection for approximately four hours. The survey crew was able to complete the survey later that afternoon.

The survey crew began at the dam and collected data on pre-plotted range lines (transects) that were spaced 500 feet apart and designed to be perpendicular to the channel for the best cross-section results. A data point that consisted of latitude, longitude and depth was collected each second. Data were collected on 87 of the 90 pre-plotted survey range lines. The survey crew also collected data on irregular transects

when navigational hazards such as trees and stumps or shallow depths kept the crew from driving on the pre-plotted lines. Approximately 22056 data points were collected over the 36.2 miles traveled during the survey. These points, shown in Figure 2, were stored digitally on the boat's computer in 120 data files.

The topography at Welsh Reservoir was typical of the East Texas Rolling Hills Region with elevated terrain occupied by mostly pine trees. The catchment basin of Welsh Reservoir is located on Swauano Creek and lies in a north to south direction with Welsh Dam located at the south end of the reservoir. There are several small tributaries (unnamed) that empty into the main basin from the east and west sides of the reservoir.

Welsh Electric-generating Power Plant is located along the west bank of the main catchment basin of Welsh Reservoir. Water is circulated throughout the reservoir for cooling purposes for the power plant. The intake channel is located on the west bank near the dam. Water is pumped through the power plant and is discharged upstream of the power plant and catchment basin. This allows the water to cool in the main body of the reservoir before being recirculated through the power plant. The survey crew was unable to collect data in all portions of the intake and discharge channels because of security structures. Due to the volume of water flowing through these channels, it is expected there is a minimum amount of sediment located in the channels.

Mr. Winston Holley of American Electric Power provided an estimate of the surface area and volume of the discharge pocket and canal that were not accessible by TWDB staff during their survey. The area given was 60 surface acres with an estimated average depth of 10 ft. Assuming a retangular profile the resulting 600 ac-ft of volume was evenly distributed over the upper ten feet of the reservoir and are included in Appendix A (Reservoir Volume Table). The Digitial Terrain Model described in the following section uses the input boundary file including the discharge pocket and canal as the final area at conservation pool elevation.

Only a few residences were noted along the east bank in the main basin. A public boat ramp was located on the west bank in the upper end of the reservoir. The remainder

of the land surrounding the lake was left undisturbed. The fact that a limited amount of development was present or the lack of fishing piers and boat ramps on Welsh Reservoir made it easier for the survey crew to collect data along the shoreline.

Native plants and ground cover was observed around the majority of the reservoir's shoreline. No major shoreline erosion was observed.

As data were collected along the pre-plotted transects, the survey crew noticed that the lake bottom was generally flat. At times there was evidence of the original creek channel (thalweg) when the survey crew crossed over Swauano Creek.

The majority of the lake was clear of navigational hazards such as trees, rocks and debris. It was only in the upper reaches of the lake and in the channel of the Swauano Creek that the crew encountered such hazards.

Data Processing

The collected data were downloaded from diskettes onto TWDB's network disk drives. Tape backups were made for future reference. To process the data, the EDIT routine in the HYPACK Program was run on each raw data file. Data points such as depth spikes or data with missing depth or positional information were deleted from each file. A correction for the reservoir elevation at the time of data collection was also applied to each file during the EDIT routine. During the November survey, the water surface remained at elevation 319.9 ft according to elevation data provided by the AEP/SWEPCO gauge. After all corrections were applied to the raw data file, the edited file was saved with a different extension. The edited files were combined into a single (x,y,z) data file which was used with the GIS software to develop a model of the lake's bottom surface.

The resulting data file was downloaded to a Dell Precision 410 workstation running the Microsoft's Windows NT 4.0 with service pack 6.0, Environmental System

Research Institute's (ESRI) ArcGIS software was used to convert the data to a MASS points file. The MASS points and the boundary file were then used to create a Digital Terrain Model (DTM) of the lake's bottom surface using Arc/Info's TIN software module. The module generates a triangulated irregular network (TIN) from the data points and the boundary file using a method known as Delauney's criteria for triangulation. A triangle is formed between three non-uniformly spaced points, including all points along the boundary. If there is another point within the triangle, additional triangles are created until all points lie on the vertex of a triangle. All of the data points are used in this method. The generated network of three-dimensional triangular planes represents the actual bottom surface. With this representation of the bottom, the software then calculates elevations of each triangular surface plane by determining the elevation along the leg of each triangle. The reservoir area and volume can be determined from the triangulated irregular network created using this method of interpolation. Volumes and area were calculated from the TIN for the entire reservoir at one-tenth of a foot interval from minimum elevation to conservation pool level. From elevation 276.1-ft to 320-ft, the surface areas and volumes of the reservoir were computed using the ArcGIS software. The computed reservoir volume table is presented in Appendix A and the area table is presented in Appendix B. Graphs for the volume and area tables can be found in Appendix C and D respectively.

Other products developed from the model include a shaded elevation range map (Figure 3) and a shaded depth range map (Figure 4). To develop these maps, the TIN was converted to a lattice using the TINLATTICE command and then to a polygon coverage using the LATTICEPOLY command. Linear filtration algorithms were applied to the DTM to produce smooth cartographic contours. The resulting elevation contour map of the bottom surface at two-foot intervals is presented in Figure 5.

RESULTS

Results from the 2001 TWDB survey indicate Welsh Reservoir encompasses 1,269 surface acres and contains a total volume of 20,242 ac-ft at the conservation pool

elevation of 320.0 ft msl (gauge datum). Dead pool storage, the volume below the invert elevation of the low-flow outlet pipe at 295.0 ft is 1811 ac-ft. Thus, the usable conservation storage (total volume - dead storage) for Welsh Reservoir is 18,431 ac-ft. The shoreline at conservation pool elevation was calculated to be approximately 25 miles. The deepest point that was measured during the survey was at elevation 276.1 ft and corresponding to a depth of 43.9 ft was located approximately 600 ft upstream from Welsh Dam.

SUMMARY AND COMPARISONS

Welsh Reservoir was completed in September 1975. Storage calculations in 1974 (Camp Dresser & McKee Consulting Engineers, Phase I Inspection Report National Dam Safety Program, 1979) reported the volume at conservation pool elevation 320.0-ft msl to be 23,587 ac-ft with a surface area of 1,365 acres. The current survey measured 1,269 surface acres, or a difference of 96 surface acres.

Results indicate that the reservoir's volume at the conservation pool elevation of 320.0 ft is 20,242 ac-ft. The total design volume of the reservoir was 23,587 ac-ft; thus it appears that 3,345 ac-ft of volume have been lost to siltation.

Comparisons between the original design information and the 2001 data collection set is difficult and some apparent changes might simply be due to methodological differences. It is recommended that the similar survey be performed in five to ten years or after major flood events to monitor changes to the lake's storage volume.

Year	1975 (Original Design)	2001 (TWDB Survey)
Area (acres)	1,365	1,269
Volume (acre-feet)	23,587	20,242

Table 1. Area and volume comparisons at elevation 320.0 ft msl.

REFERENCES

1. Camp Dresser & McKee Consulting Engineers, Phase I Inspection Report National Dam Safety Program, 1979

2. Freese and Nichols Inc. Consulting Engineers, Safety Inspection of Swauano Creek Dam at Welsh Power Plant, September 1989

Appendix A

Welsh Reservoir

RESERVOIR VOLUME TABLE

TEXAS WATER DEVELOPMENT BOARD — NOVEMBER 2001 SURVEY

VOLUME IN ACRE-FEET — ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
276		0	0	0	0	0	0	0	0	0
277	0	0	0	0	0	0	0	0	0	0
278	0	0	0	0	0	0	0	0	0	0
279	0	0	0	0	1	1	1	1	1	1
280	1	1	1	1	1	1	1	1	2	2
281	2	2	2	2	2	3	3	3	3	3
282	4	4	4	5	5	5	6	7	8	9
283	10	11	13	15	16	18	21	23	26	28
284	31	34	37	41	44	47	51	55	59	63
285	68	72	77	82	88	93	99	105	112	119
286	126	133	140	148	156	164	173	181	190	199
287	208	218	228	238	248	259	270	281	292	303
288	315	327	339	351	363	376	389	402	415	428
289	442	456	470	484	499	514	529	544	560	576
290	593	610	626	644	661	679	698	716	735	755
291	775	795	815	836	857	879	900	923	945	968
292	992	1015	1039	1063	1087	1112	1137	1162	1188	1213
293	1239	1266	1292	1319	1346	1373	1401	1429	1457	1485
294	1514	1543	1572	1601	1630	1660	1690	1720	1750	1781
295	1811	1842	1873	1905	1936	1968	2000	2032	2065	2097
296	2130	2163	2197	2230	2264	2298	2332	2367	2401	2436
297	2471	2506	2541	2577	2613	2649	2685	2722	2759	2797
298	2834	2872	2911	2949	2988	3027	3067	3107	3147	3187
299	3228	3269	3311	3352	3394	3436	3479	3522	3565	3609
300	3653	3698	3742	3788	3833	3879	3925	3972	4019	4066
301	4114	4162	4211	4260	4309	4359	4409	4459	4510	4561
302	4613	4665	4718	4771	4824	4878	4932	4986	5041	5096
303	5151	5207	5263	5320	5376	5433	5491	5549	5607	5665
304	5724	5784	5843	5903	5963	6024	6084	6146	6207	6269
305	6331	6393	6456	6519	6582	6646	6710	6774	6839	6903
306	6969	7034	7100	7166	7232	7299	7366	7434	7502	7570
307	7638	7707	7776	7846	7915	7986	8056	8127	8198	8269
308	8341	8413	8485	8557	8630	8703	8777	8850	8924	8999
309	9073	9148	9224	9299	9375	9452	9528	9605	9682	9760
310	9838	9922	10007	10092	10177	10263	10349	10435	10522	10609
311	10696	10784	10873	10961	11050	11140	11229	11320	11410	11501
312	11592	11684	11776	11868	11961	12054	12147	12241	12335	12429
313	12524	12619	12715	12811	12907	13004	13101	13198	13296	13394
314	13493	13592	13691	13791	13891	13992	14093	14194	14296	14398
315	14500	14603	14707	14810	14915	15019	15125	15230	15336	15443
316	15550	15658	15766	15875	15984	16094	16204	16315	16426	16538
317	16651	16764	16877	16991	17106	17221	17337	17453	17569	17686
318	17804	17922	18040	18159	18278	18398	18518	18638	18759	18880
319	19002	19124	19247	19370	19493	19617	19741	19865	19990	20116
320	20242									

Appendix B

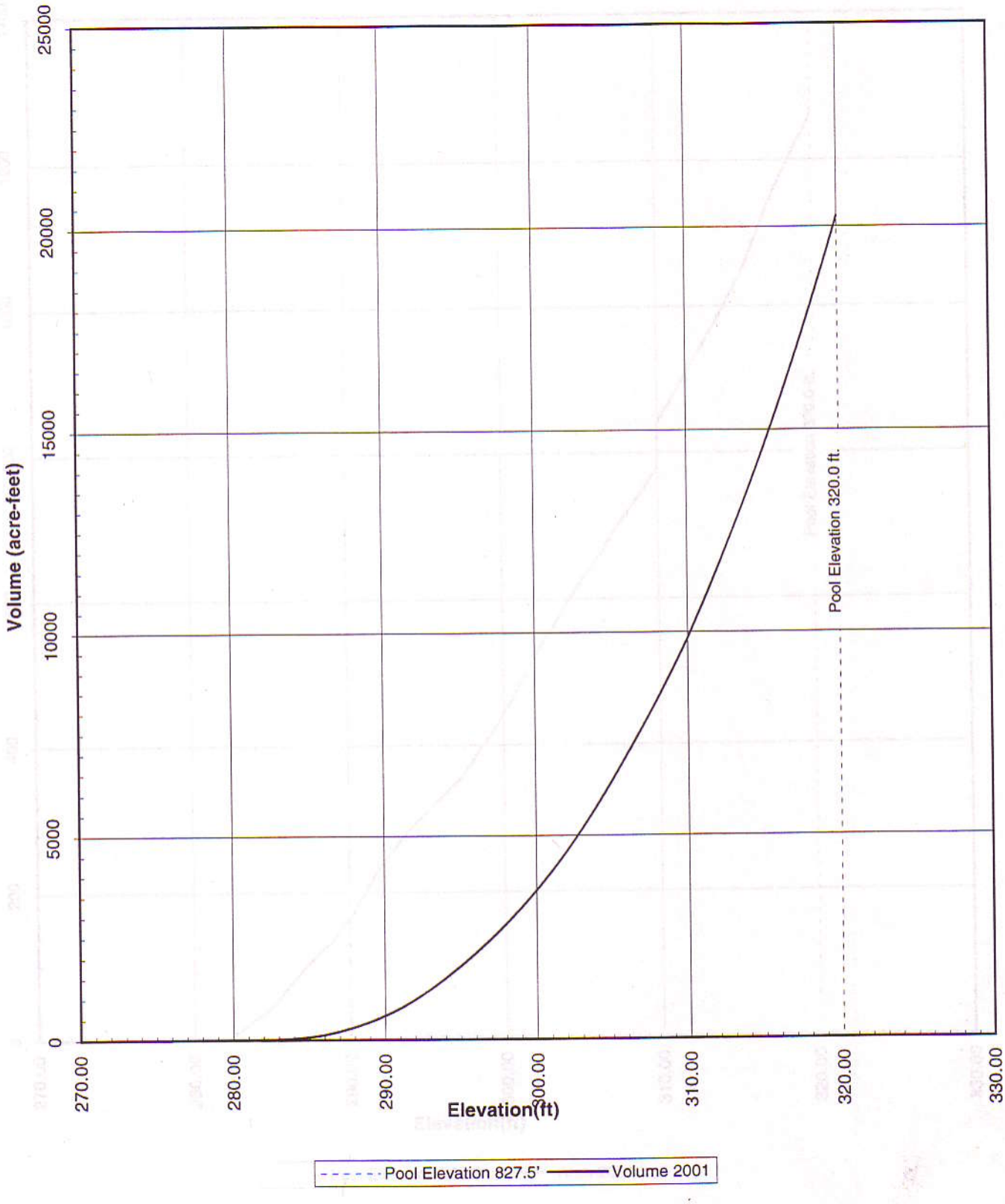
Welsh Reservoir

RESERVOIR AREA TABLE

TEXAS WATER DEVELOPMENT BOARD — NOVEMBER 2001 SURVEY

AREA IN ACRES — ELEVATION INCREMENT IS ONE TENTH FOOT

ELEVATION in Feet	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
276		0	0	0	0	0	0	0	0	0
277	0	0	0	0	0	0	0	0	0	0
278	0	0	0	0	0	0	0	0	0	0
279	0	0	0	0	0	1	1	1	1	1
280	1	1	1	1	1	1	1	1	1	1
281	1	1	1	2	2	2	2	2	2	2
282	3	3	3	4	4	5	7	8	10	11
283	13	15	16	18	19	21	23	25	27	28
284	29	31	32	33	35	36	38	40	42	43
285	45	47	49	52	55	58	61	63	66	69
286	71	73	76	78	81	83	85	87	90	92
287	95	98	100	102	104	107	109	111	113	115
288	117	119	121	123	125	127	129	131	133	135
289	137	139	142	145	148	151	154	157	160	163
290	165	168	171	174	178	182	185	189	192	196
291	199	203	206	210	213	217	220	224	228	231
292	234	237	240	242	245	248	250	253	256	259
293	261	264	267	270	272	275	277	280	282	284
294	287	289	291	293	296	298	300	302	304	306
295	308	310	312	315	317	319	321	323	326	328
296	330	332	334	336	338	341	343	345	347	349
297	351	353	355	357	360	363	366	369	372	376
298	378	381	385	388	391	394	397	400	403	406
299	409	412	415	418	421	424	428	431	435	439
300	443	446	450	453	457	460	464	467	471	476
301	480	484	488	492	495	499	503	507	511	515
302	520	524	528	532	535	539	542	546	549	552
303	555	559	562	565	569	573	577	580	584	587
304	591	594	597	600	603	606	609	613	616	620
305	623	626	629	632	635	638	640	643	646	649
306	653	656	659	663	666	670	673	677	680	684
307	687	690	693	696	700	703	706	709	712	715
308	718	721	724	727	730	733	736	739	742	745
309	748	752	755	758	761	765	768	771	774	778
310	842	845	848	851	855	858	862	865	869	872
311	876	880	884	888	892	896	900	903	907	911
312	914	918	922	925	929	932	936	939	943	946
313	950	953	957	962	965	969	973	976	980	984
314	988	992	996	999	1003	1007	1011	1015	1019	1023
315	1027	1032	1036	1040	1045	1049	1054	1059	1064	1069
316	1074	1079	1084	1090	1095	1100	1106	1111	1116	1122
317	1127	1133	1138	1143	1148	1153	1158	1163	1168	1173
318	1177	1182	1186	1190	1194	1198	1202	1207	1211	1215
319	1219	1223	1227	1231	1235	1240	1244	1248	1252	1256
320	1269									



Welsh Reservoir
November 2001
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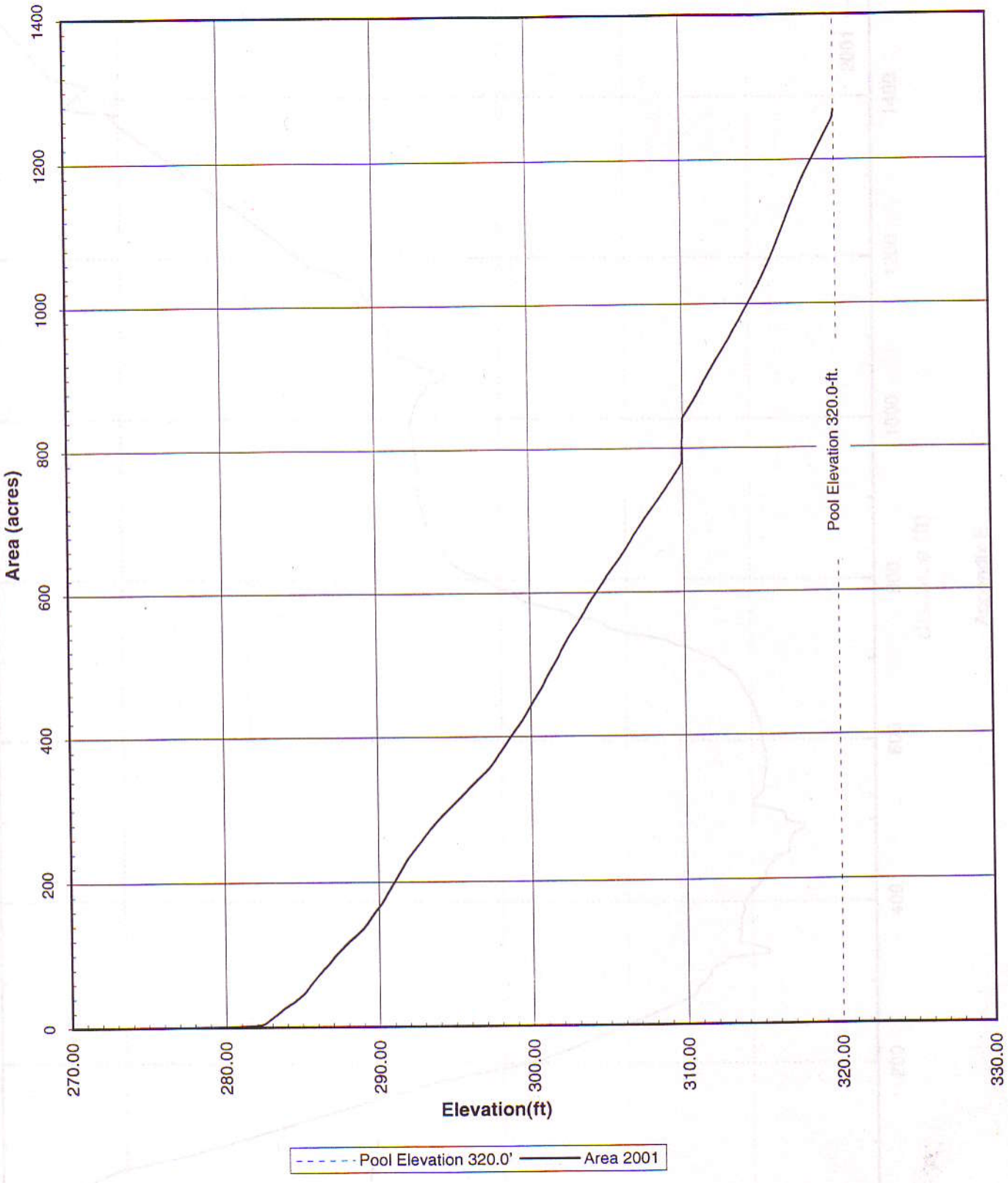
Appendix C Elevation vs. Volume

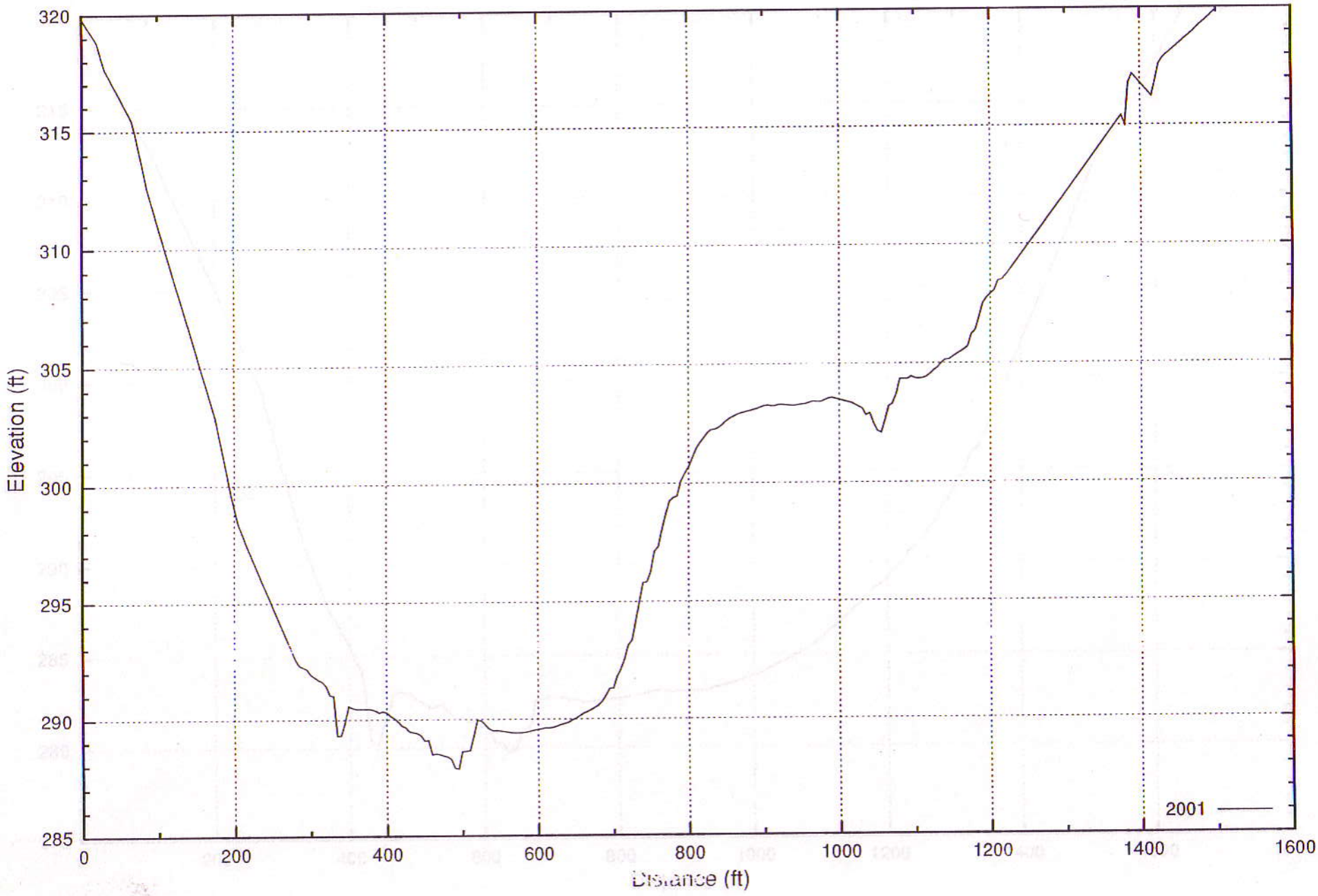


Welsh Reservoir
November 2001
Prepared by: TWDB

Appendix D Elevation vs. Area

WELSH RESERVOIR

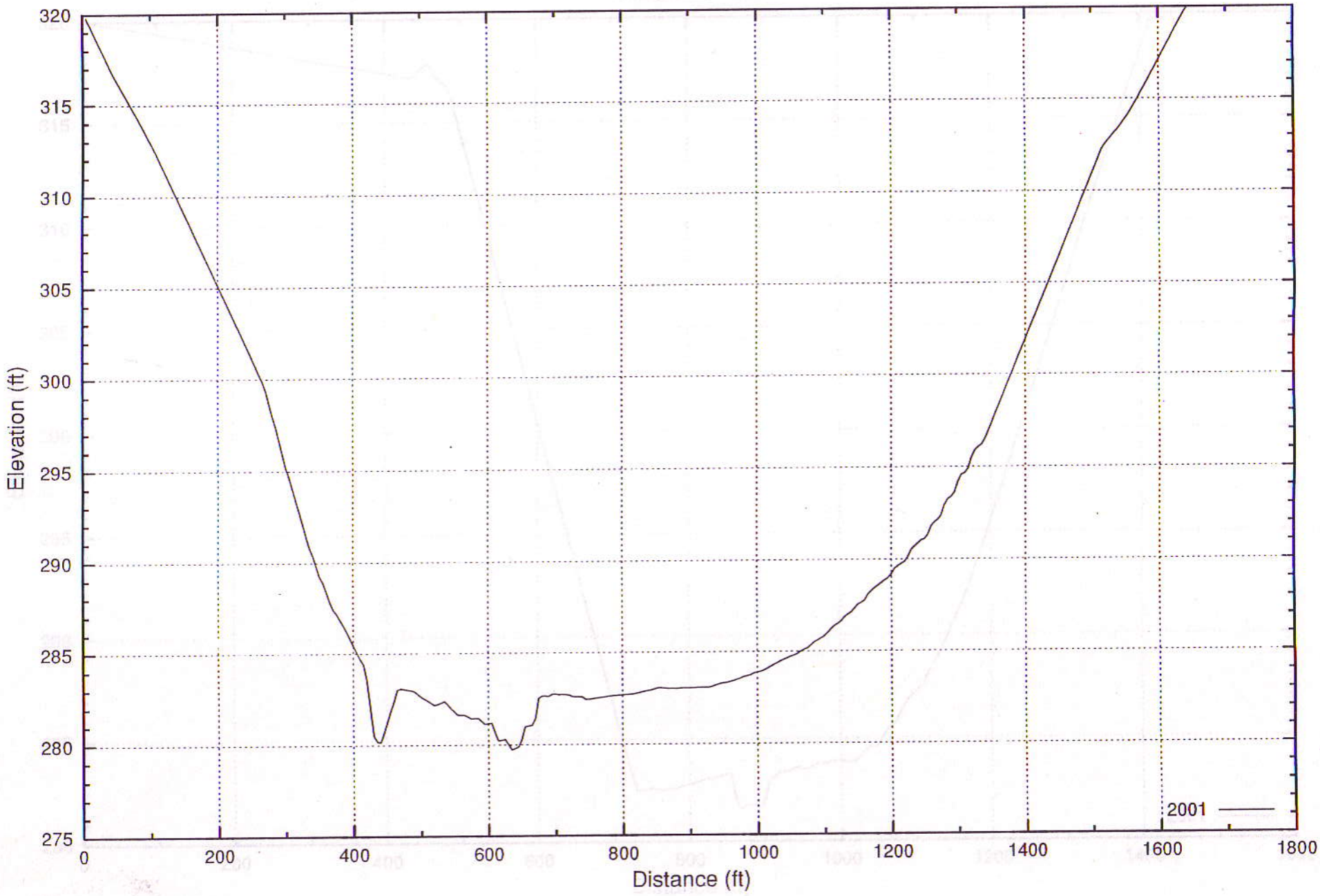
Rangeline 001



Appendix E

WELSH RESERVOIR

Rangeline 002



WELSH RESERVOIR

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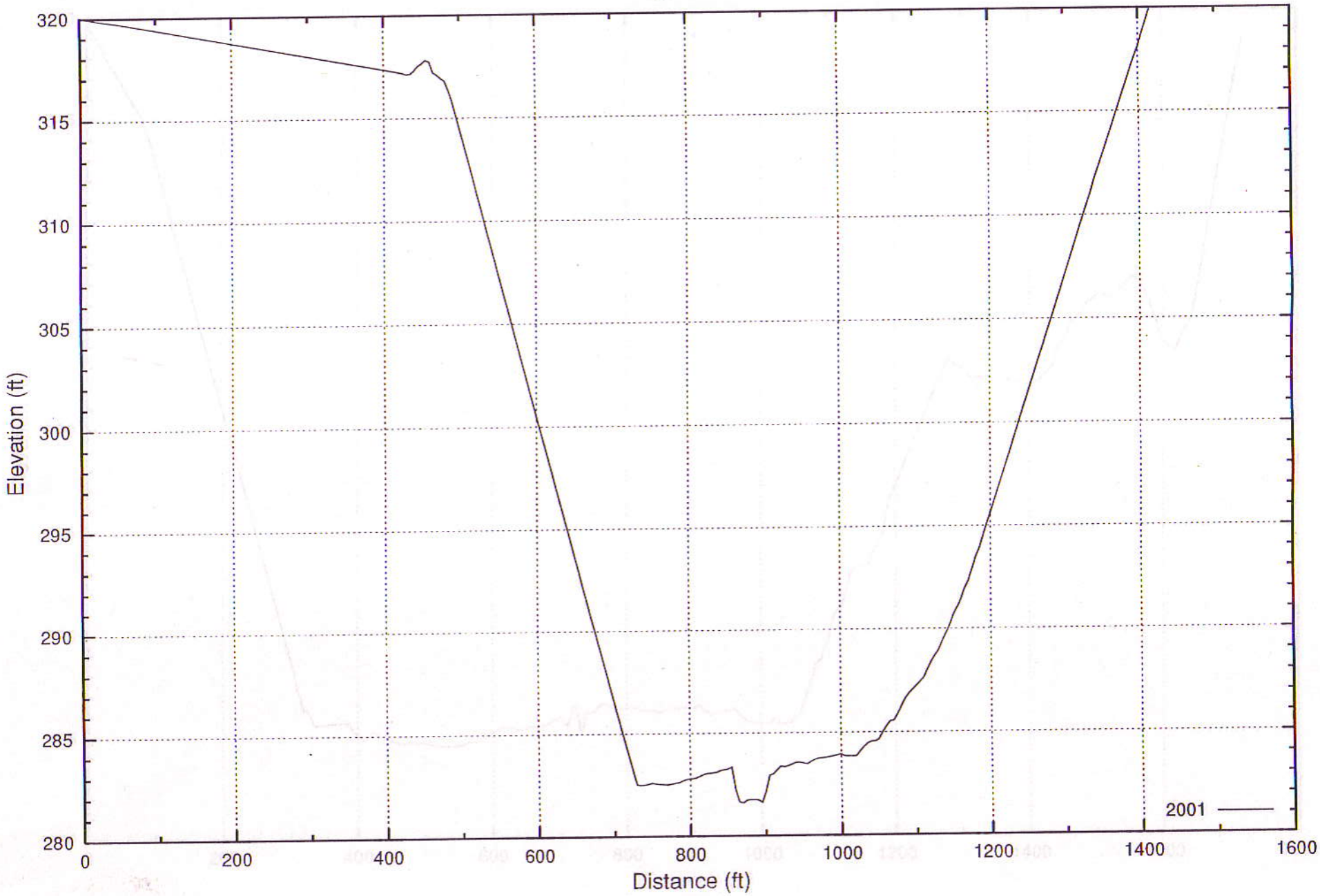
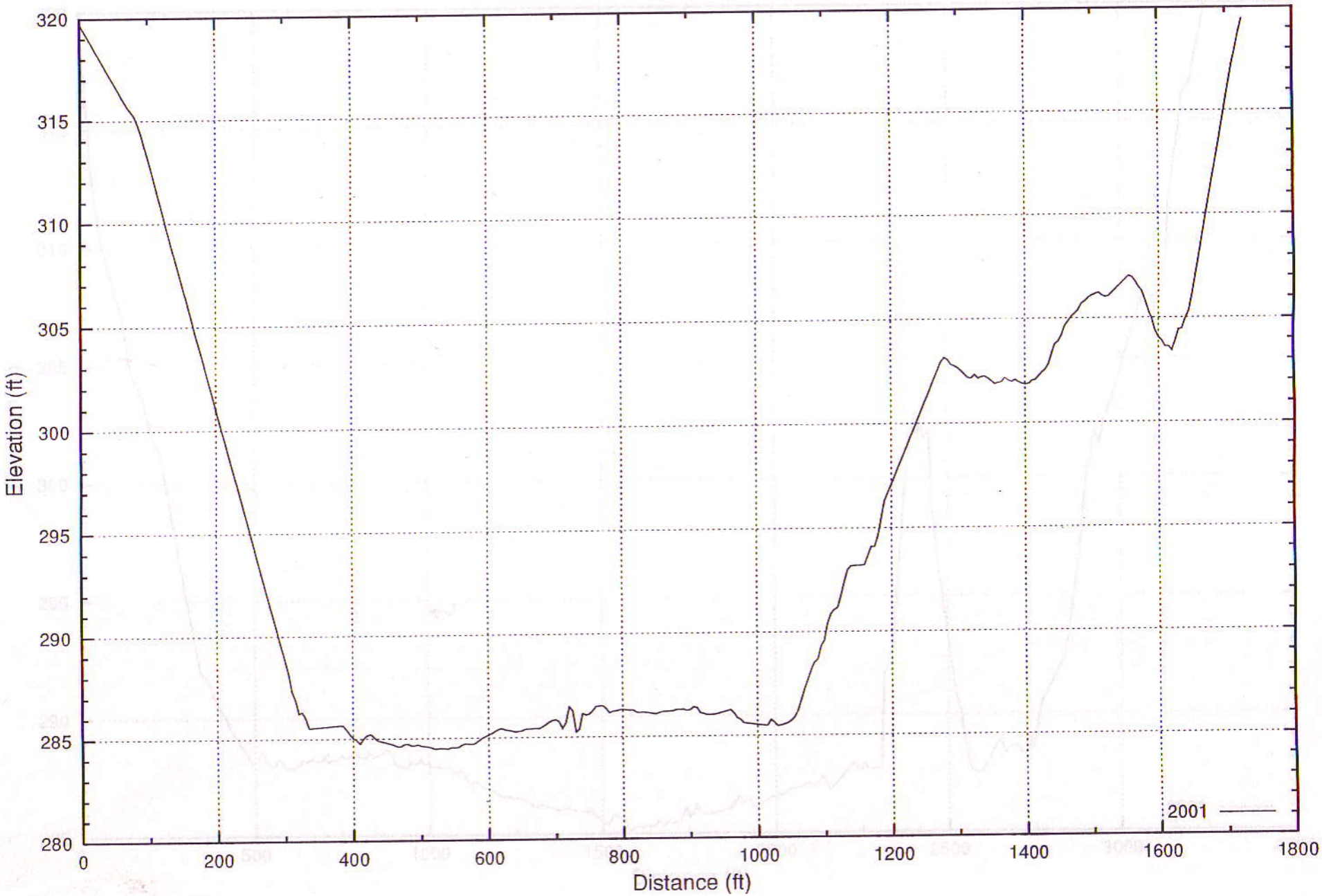


Appendix E

WELSH RESERVOIR

Rangeline 004



Appendix E

WELSH RESERVOIR

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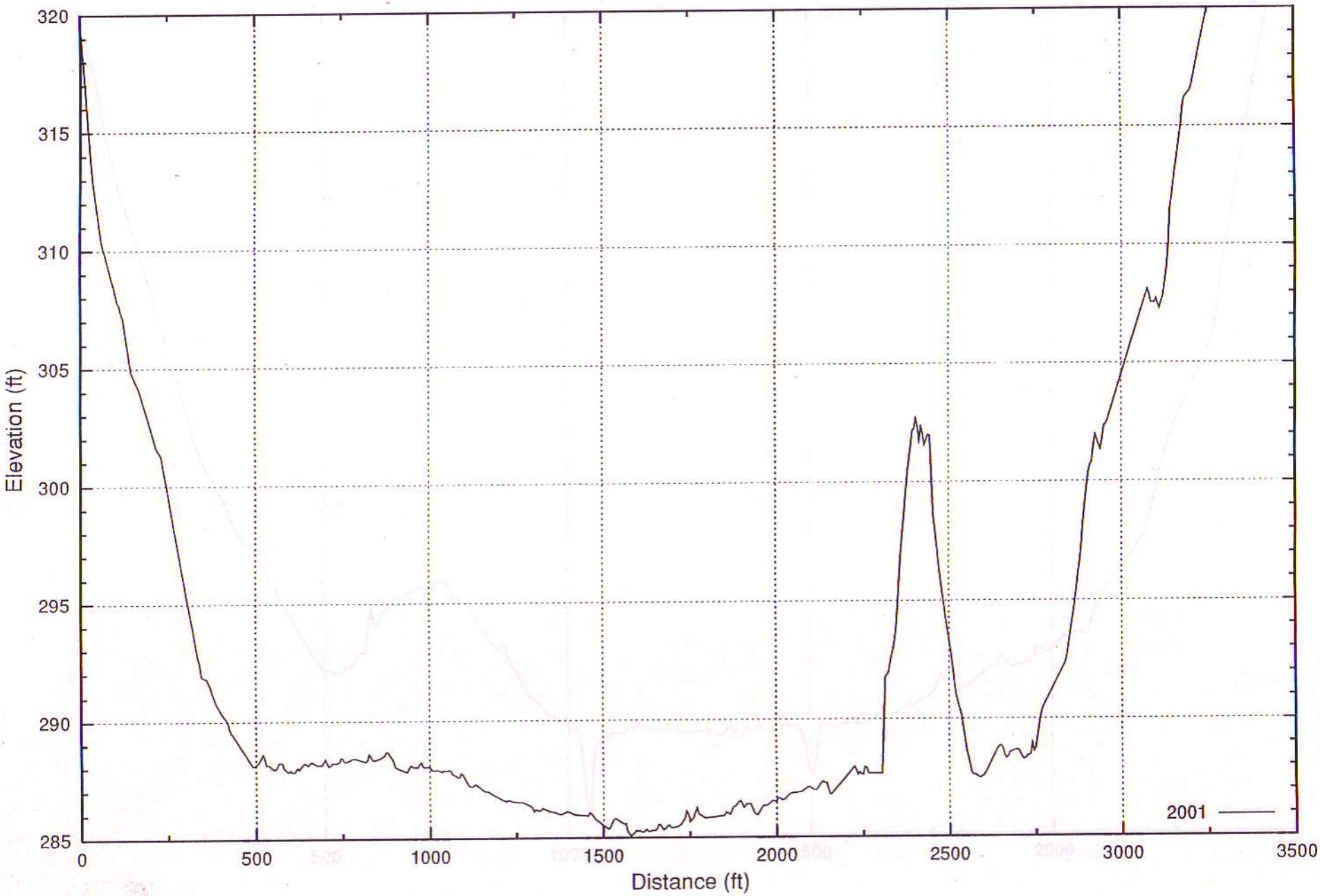

Appendix E

WELSH RESERVOIR

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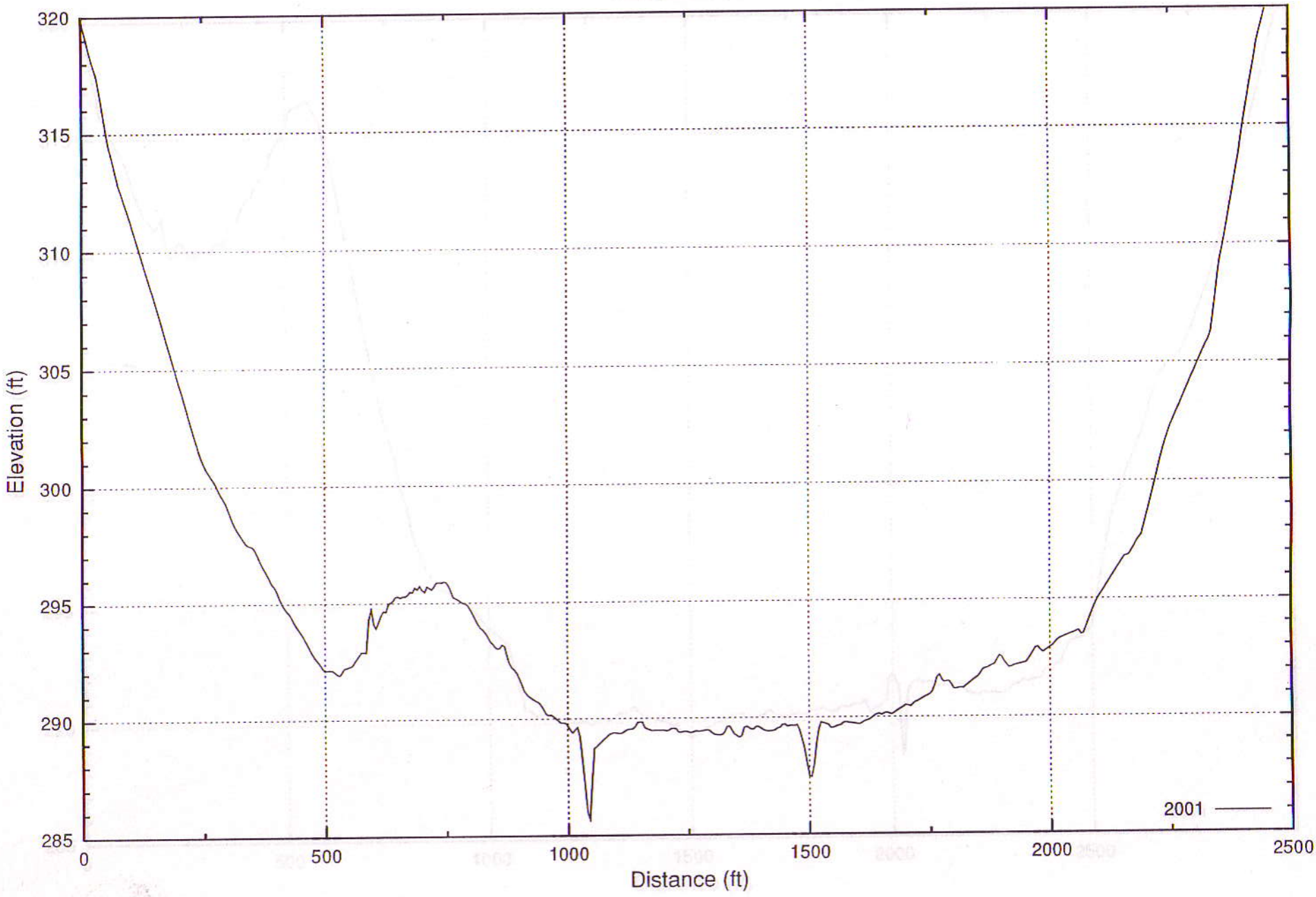
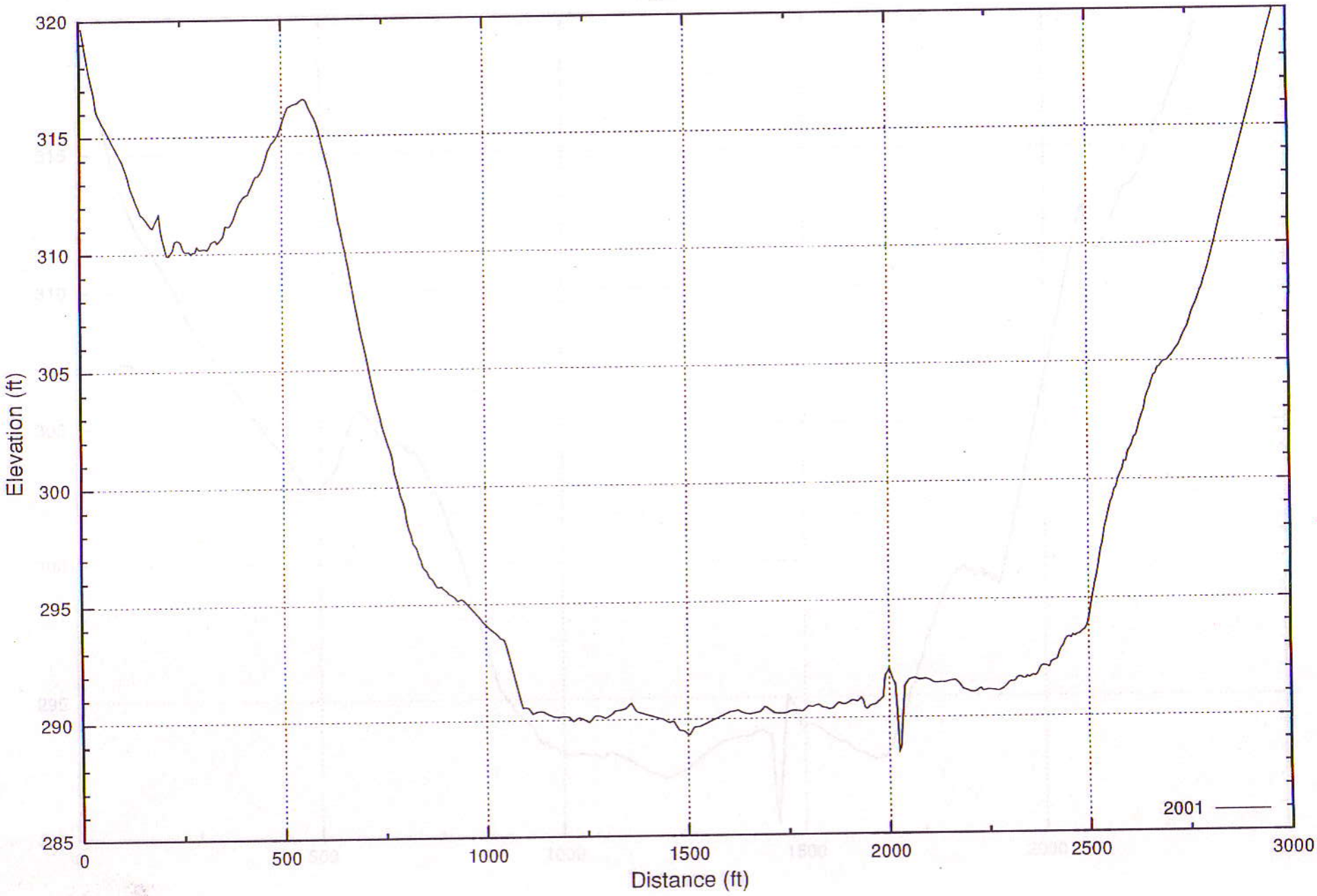


Appendix E

WELSH RESERVOIR

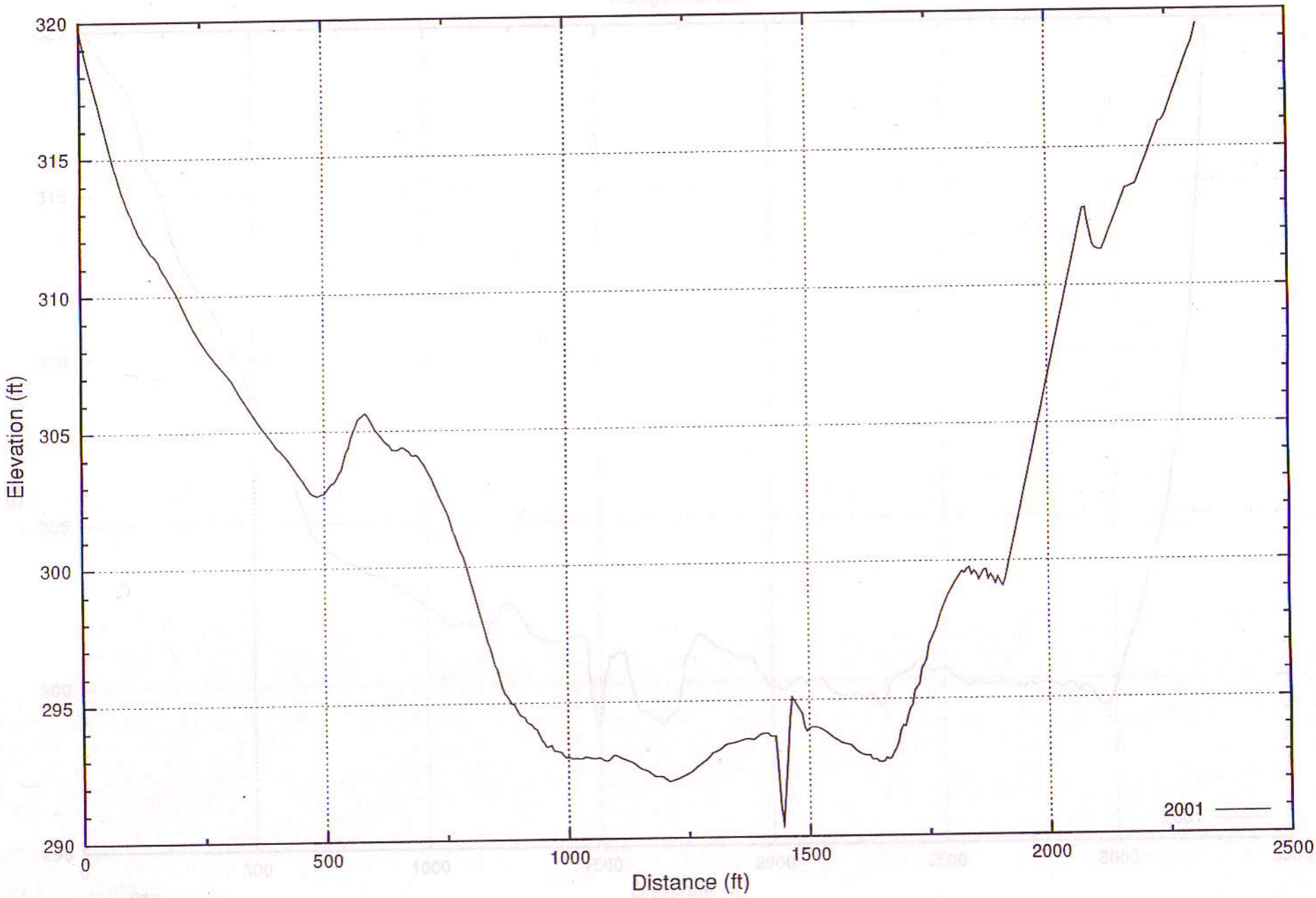
Rangeline 007



Appendix E

WELSH RESERVOIR

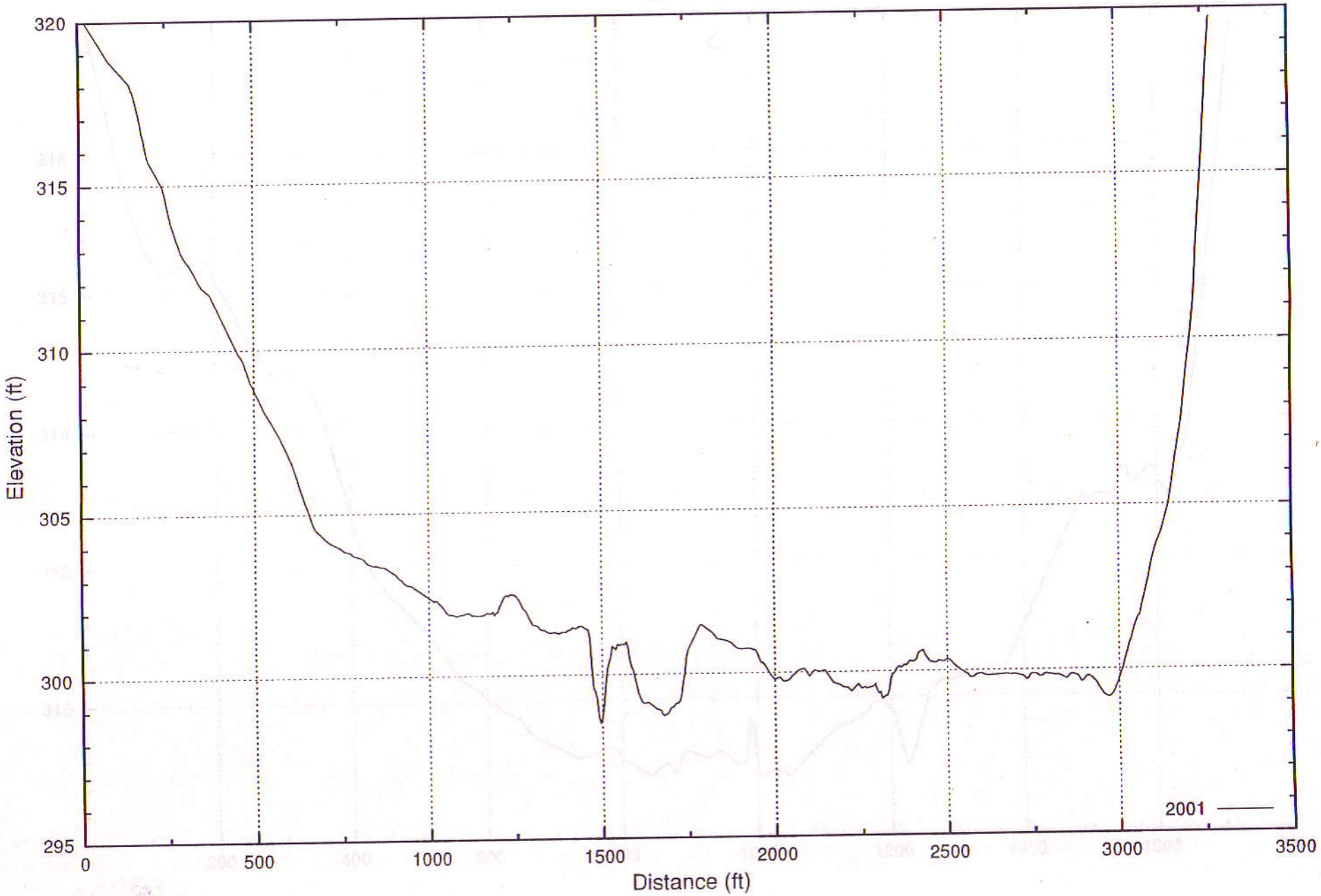
Rangeline 008



Appendix E

WELSH RESERVOIR

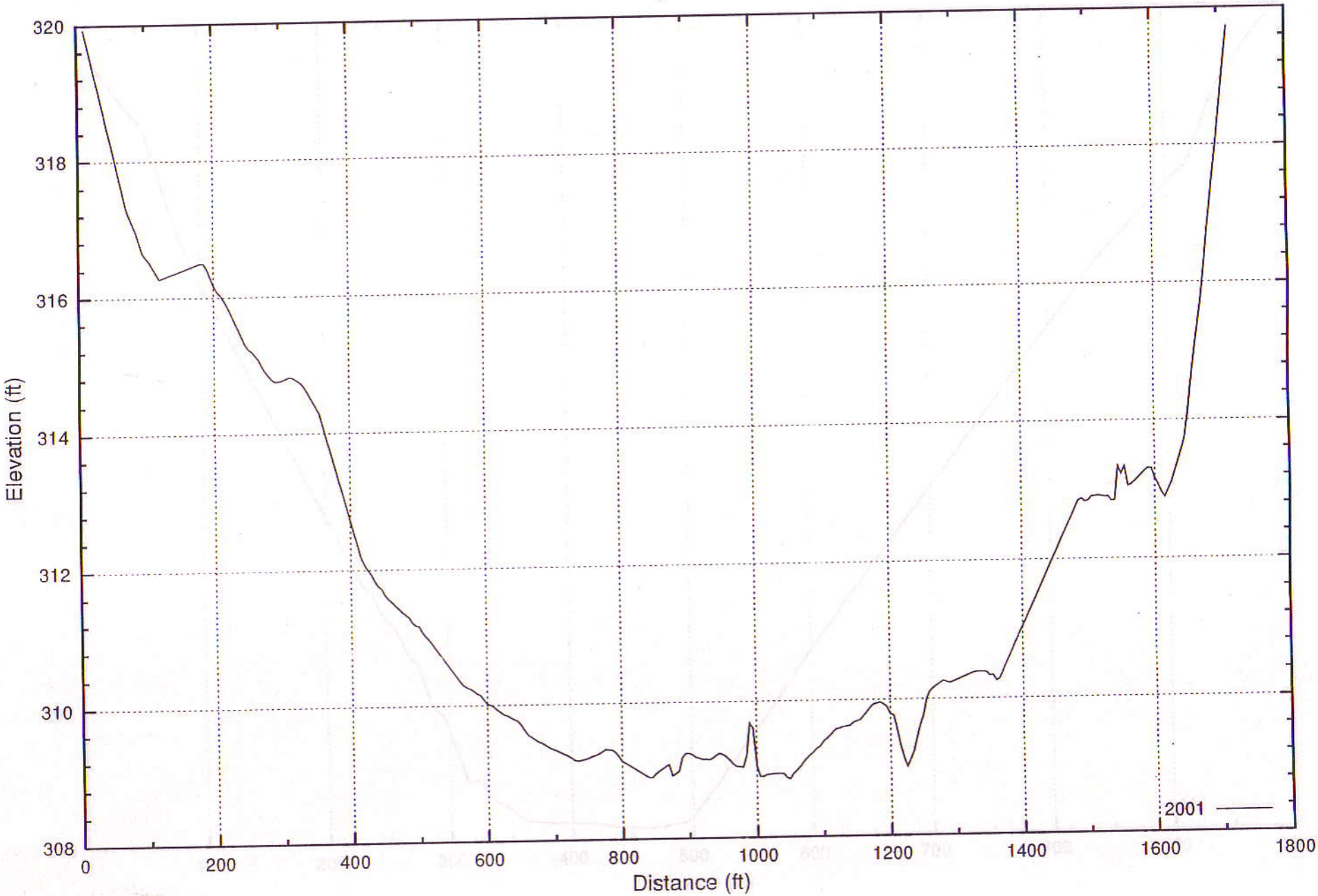
Rangeline 009



Appendix E

WELSH RESERVOIR

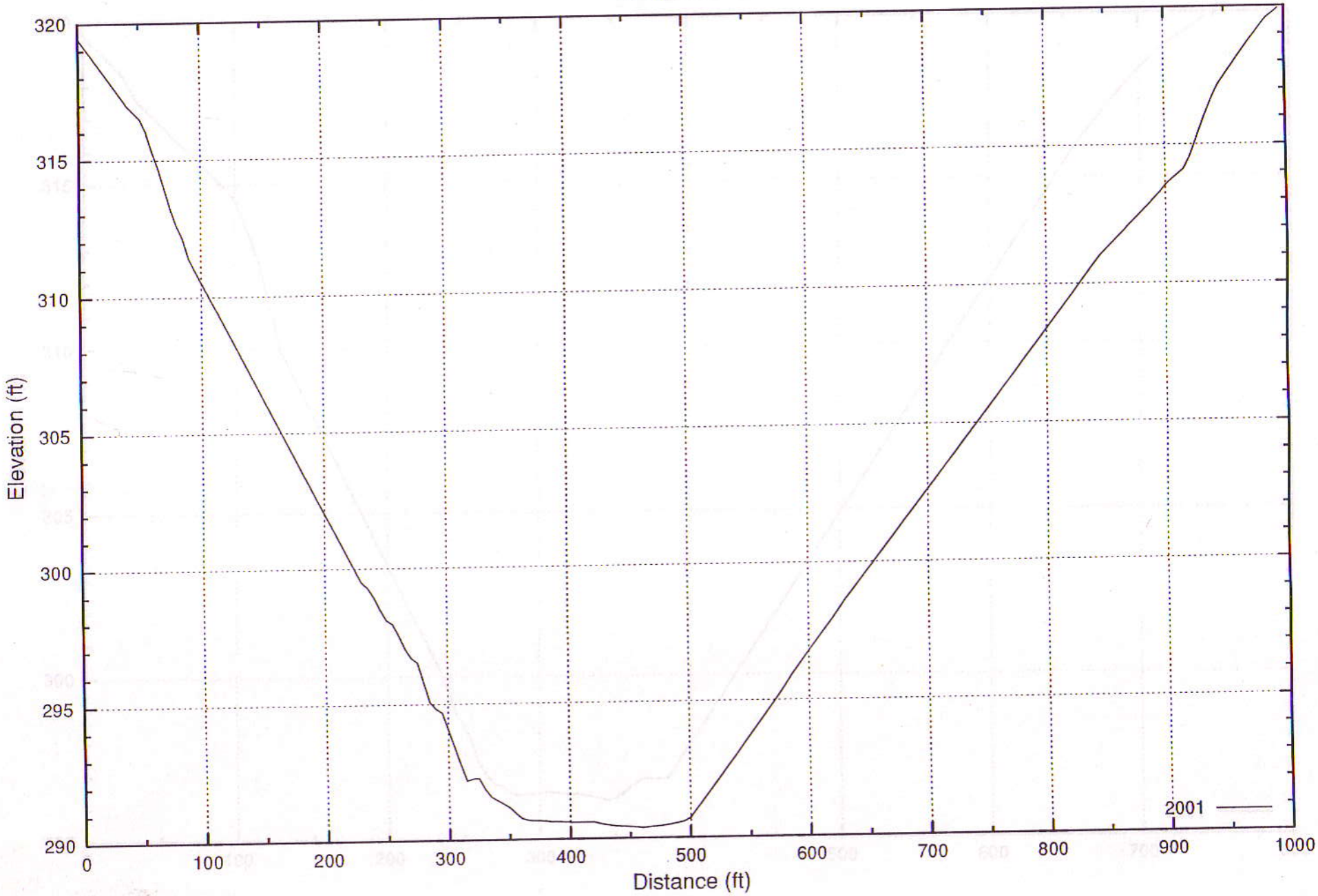
Rangeline 10



Appendix E

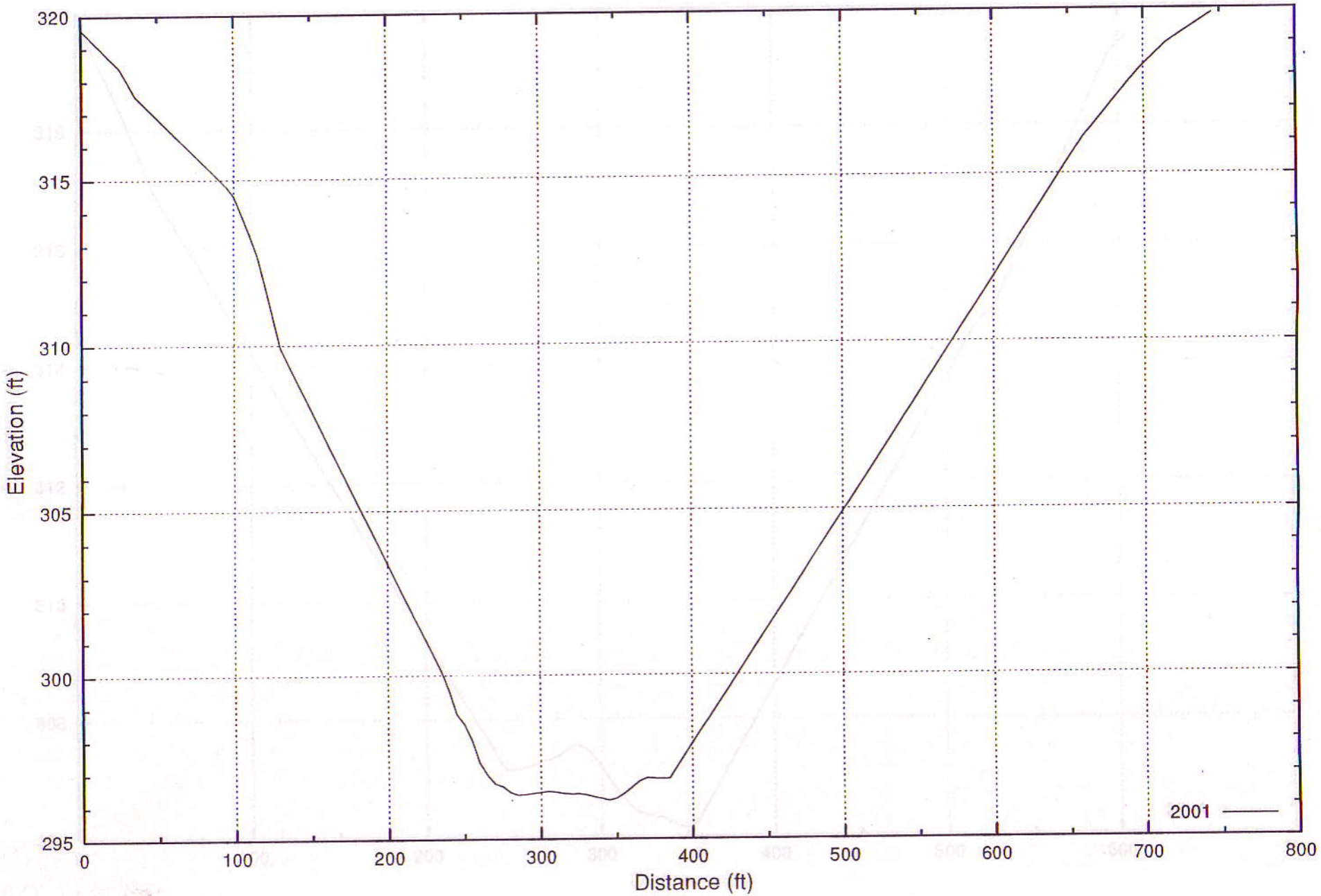
WELSH RESERVOIR

Rangeline 11



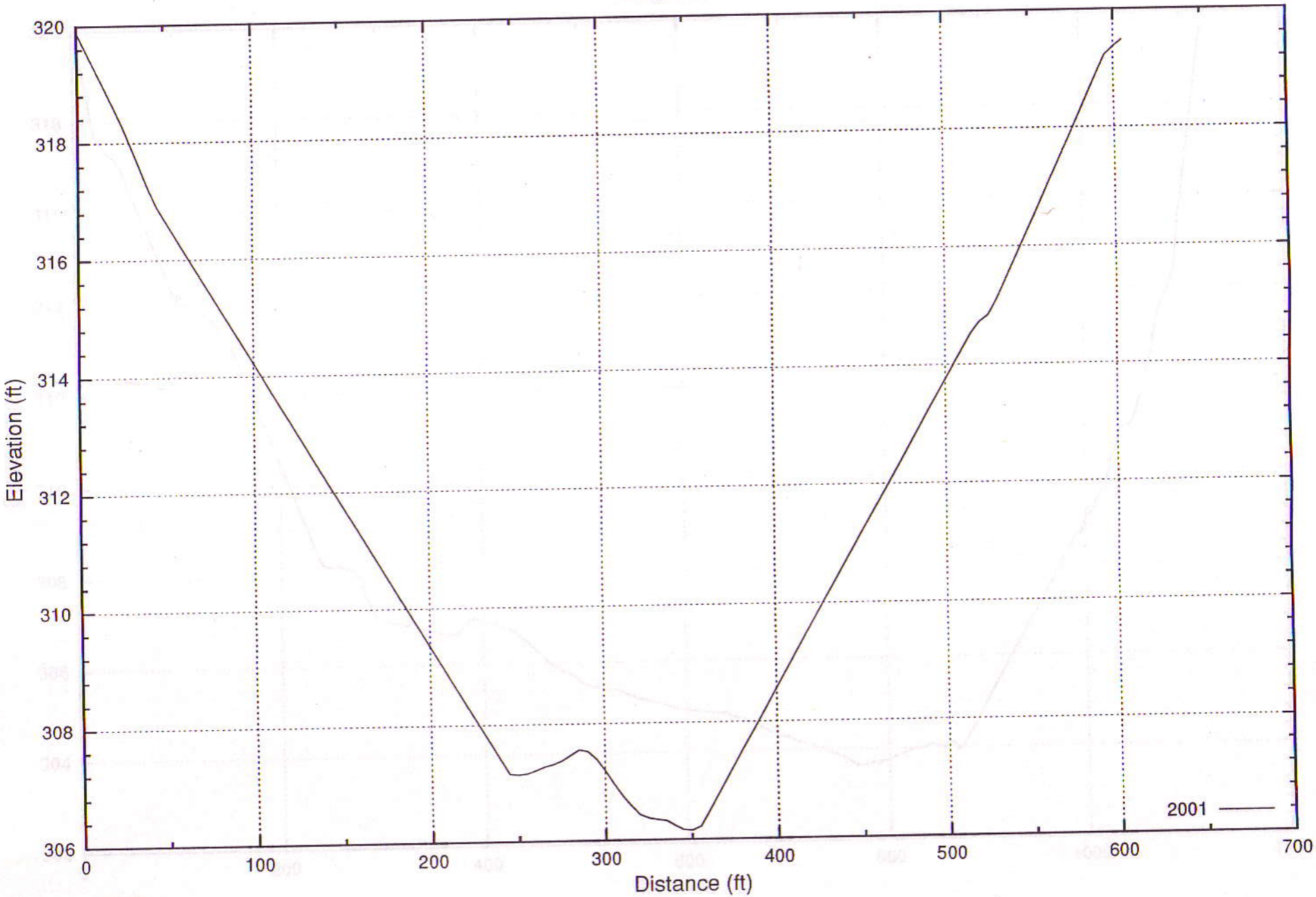
WELSH RESERVOIR

Rangeline 12



WELSH RESERVOIR

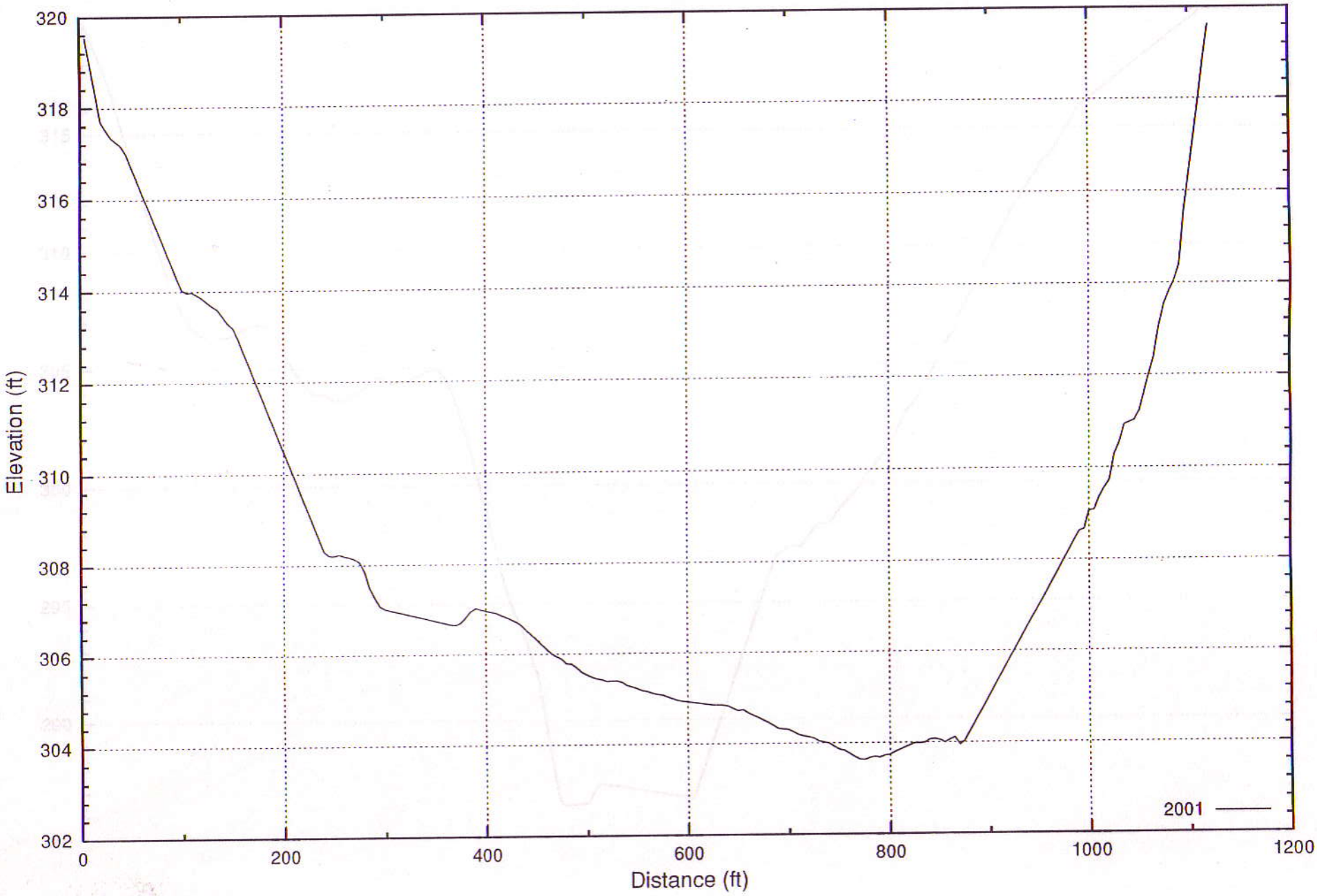
Rangeline 13



Appendix E

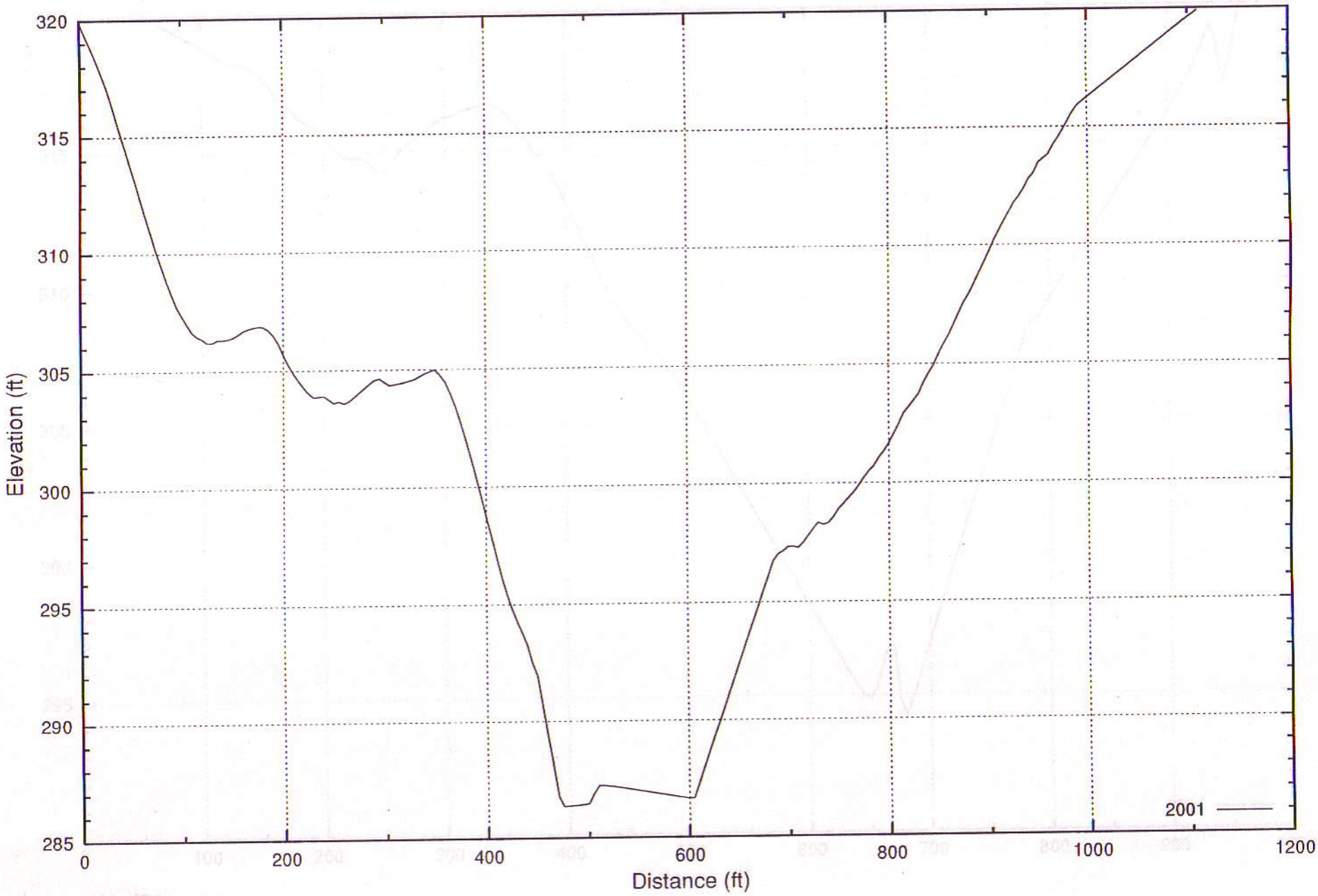
WELSH RESERVOIR

Rangeline 14



WELSH RESERVOIR

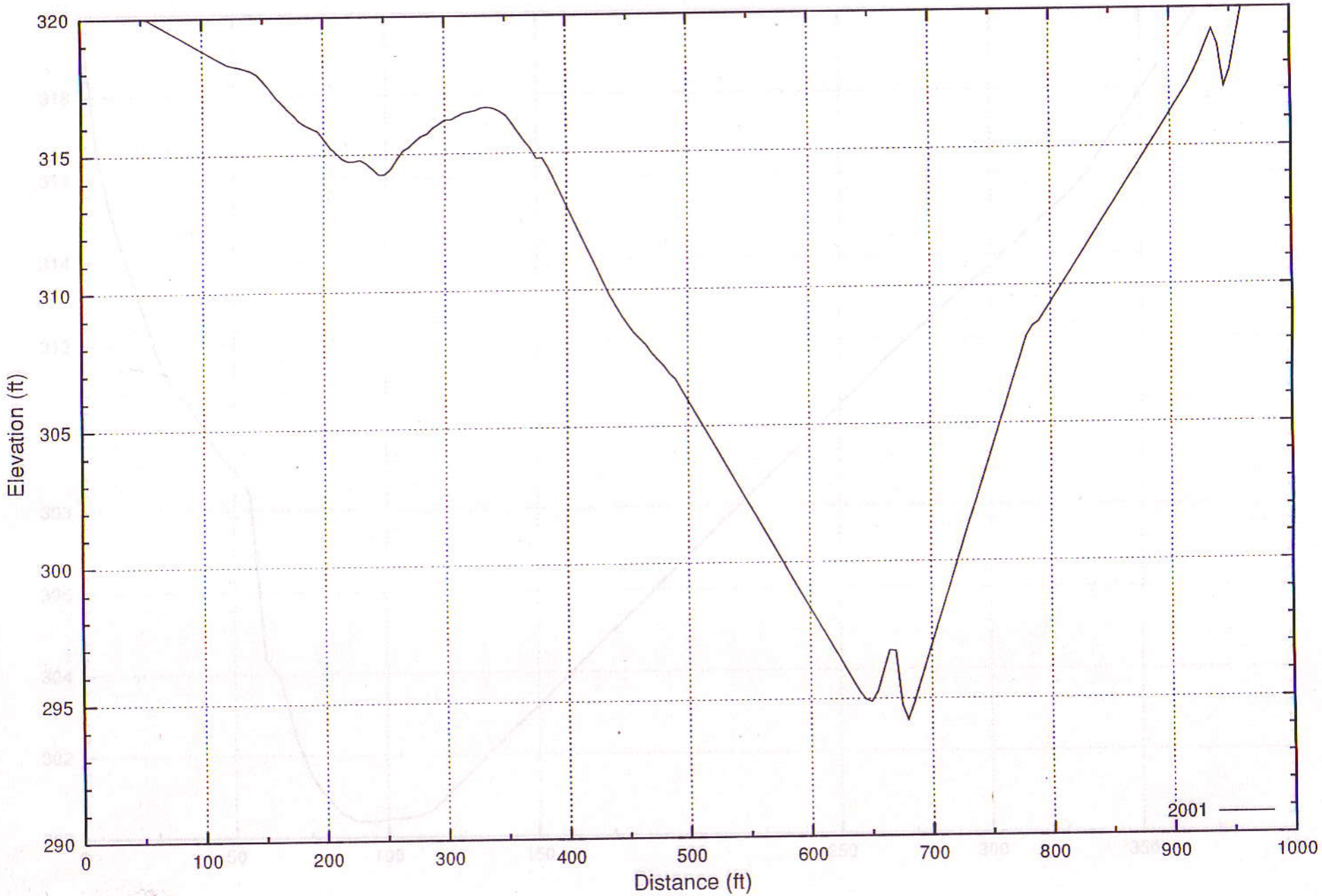
Rangeline 15



Appendix E

WELSH RESERVOIR

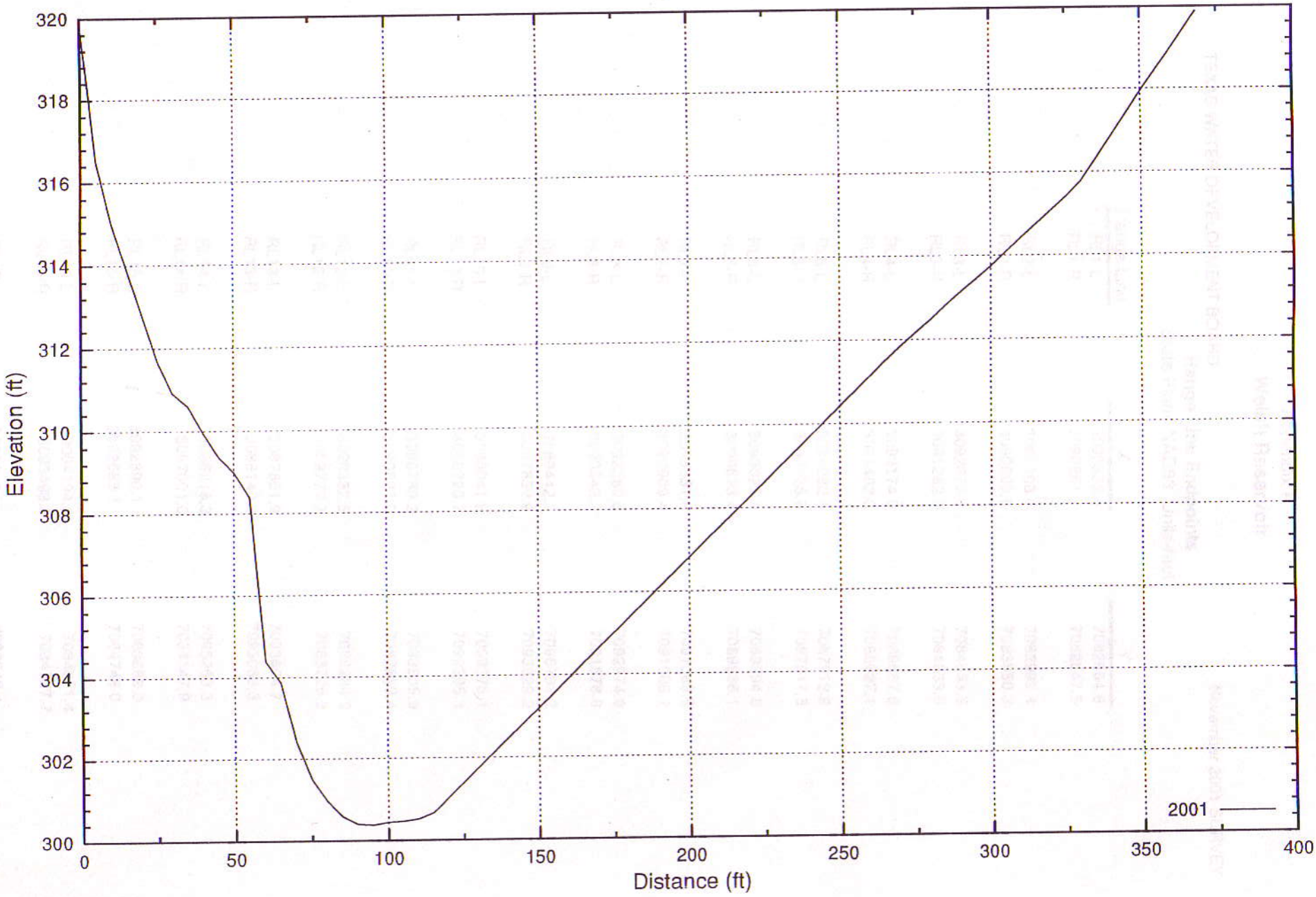
Rangeline 16



Appendix E

WELSH RESERVOIR

Rangeline 17



Appendix F

Welsh Reservoir

TEXAS WATER DEVELOPMENT BOARD November 2001 SURVEY

Range Line Endpoints

State Plane NAD83 Units-feet

Range Line	X	Y
RL1-L	3092332.4	7082864.8
RL1-R	3090851.7	7082547.5
RL2-L	3092303.6	7082999.4
RL2-R	3090899.8	7083850.3
RL3-L	3092679.6	7084853.5
RL3-R	3091262.8	7084833.5
RL4-L	3093174.0	7086667.6
RL4-R	3091462.3	7086927.1
RL5-L	3094082.4	7087912.6
RL5-R	3090755.6	7087917.5
RL6-L	3093025.1	7089394.8
RL6-R	3090623.4	7089886.1
RL7-L	3093851.6	7091388.5
RL7-R	3090909.4	7091008.7
RL8-L	3092380.5	7092974.9
RL8-R	3090342.2	7091878.8
RL9-L	3089442.2	7096793.2
RL9-R	3087839.9	7093929.2
RL10-L	3088041.8	7099376.1
RL10-R	3086320.7	7099395.3
RL11-L	3090789.2	7083835.9
RL11-R	3090621.0	7082850.4
RL12-L	3090332.5	7084234.9
RL12-R	3089779.7	7083725.3
RL13-L	3087851.9	7093604.7
RL13-R	3088140.3	7093066.3
RL14-L	3086818.3	7095263.3
RL14-R	3087001.0	7094147.9
RL15-L	3092890.1	7083658.0
RL15-R	3092683.1	7084748.0
RL16-L	3094194.2	7084071.4
RL16-R	3093493.8	7084727.7
RL17-L	3093649.7	7089042.4
RL17-R	3093463.2	7089360.0

APPENDIX G - DEPTH SOUNDER ACCURACY

This example was extracted from the Innerspace Technology, Inc. Operation Manual for the Model 443 Velocity Profiler.

For the following examples, $tD = (D - d)/V$

Where: tD = travel time of the sound pulse, in seconds (at depth = D)

D = depth, in feet

d = draft = 1.2 feet

V = speed of sound, in feet per second

To calculate the error of a measurement based on differences in the actual versus average speed of sound, the same equation is used, in this format:

$D = [t (V)]+d$

For the water column from 2 to 30 feet: V = 4832 fps

t30 = (30-1.2)/4832 = 0.00596 sec.

For the water column from 2 to 45 feet: V = 4808 fps

t45 =(45-1.2)/4808 =0.00911 sec.

For a measurement at 20 feet (within the 2 to 30 foot column with V = 4832 fps):

D20 = [((20-1.2)/4832)(4808)]+1.2 = 19.9’ (-0.1’)

For a measurement at 30 feet (within the 2 to 30 foot column with V = 4832 fps):

D30 = [((30-1.2)/4832)(4808)]+1.2

= 29.9’ (-0.1’)

For a measurement at 50 feet (within the 2 to 60 foot column with V = 4799 fps):

D50 = [((50-1.2)/4799)(4808)]+1.2

= 50.1’ (+0.1’)

For the water column from 2 to 60 feet: V = 4799 fps Assumed V80 = 4785 fps

t60 =(60-1.2)/4799

=0.01225 sec.

For a measurement at 10 feet (within the 2 to 30 foot column with V = 4832 fps):

D10 = [((10-1.2)/4832)(4799)]+1.2

= 9.9’ (-0.1’)

For a measurement at 30 feet (within the 2 to 30 foot column with V = 4832 fps):

D30 = [((30-1.2)/4832)(4799)]+1.2

= 29.8’ (-0.2’)

For a measurement at 45 feet (within the 2 to 45 foot column with V = 4808 fps):

D45 = [((45-1.2)/4808)(4799)]+1.2

= 44.9’ (-0.1’)

For a measurement at 80 feet (outside the 2 to 60 foot column, assumed V = 4785 fps):

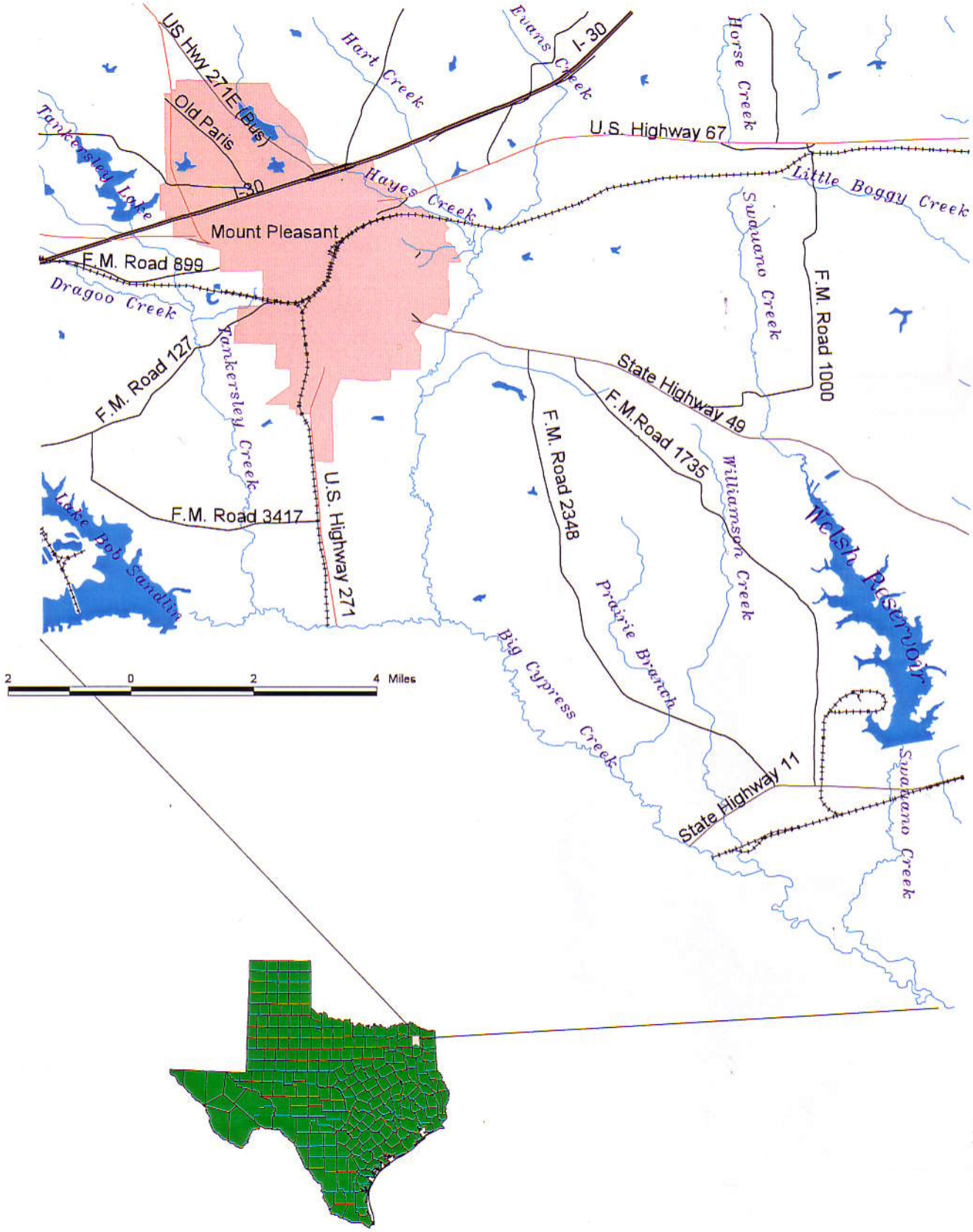
D80 = [((80-1.2)/4785)(4799)]+1.2

= 80.2’ (+0.2’)

Figure 1

WELSH RESERVOIR

Location Map

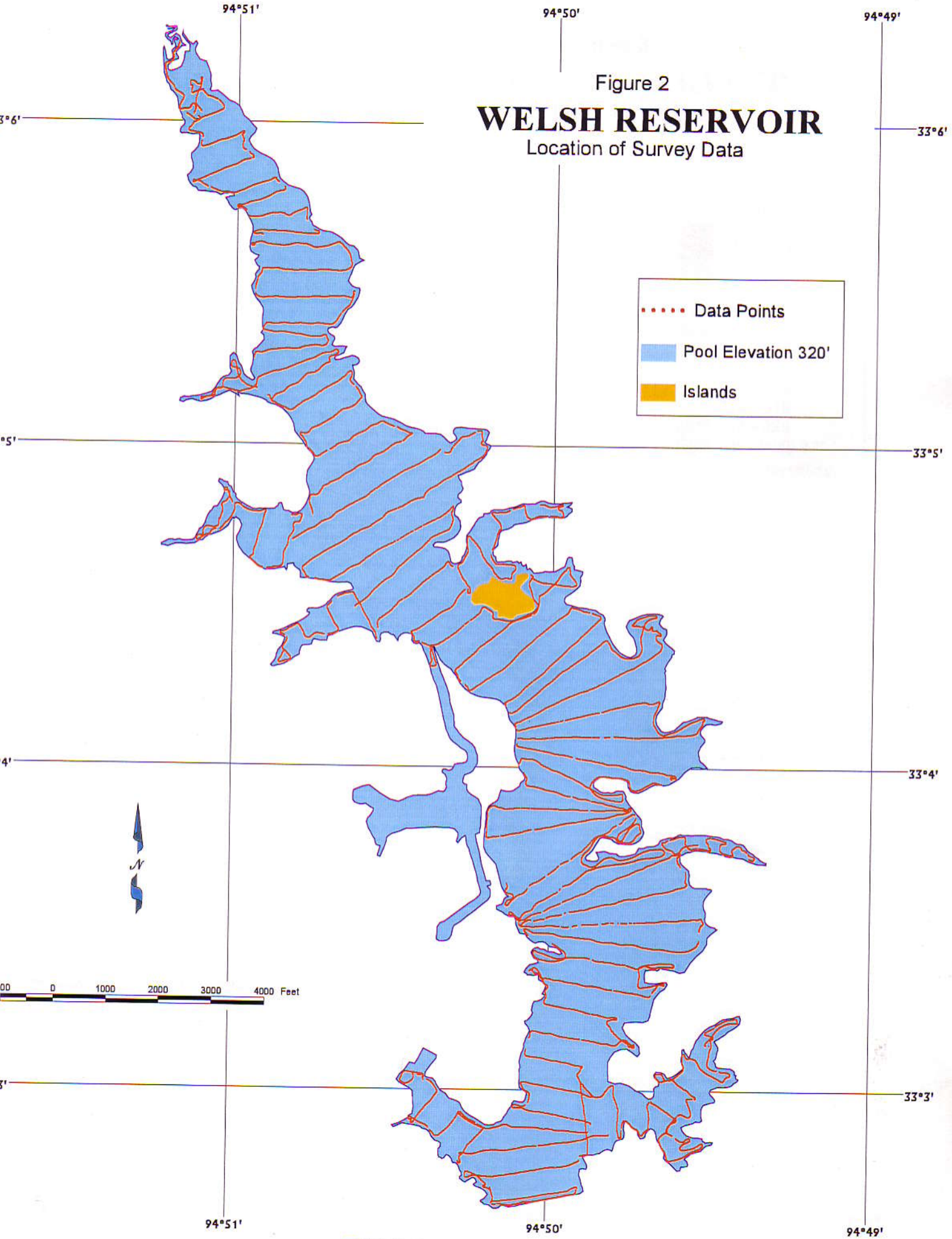


TWDB Survey November 2001

Figure 2

WELSH RESERVOIR

Location of Survey Data

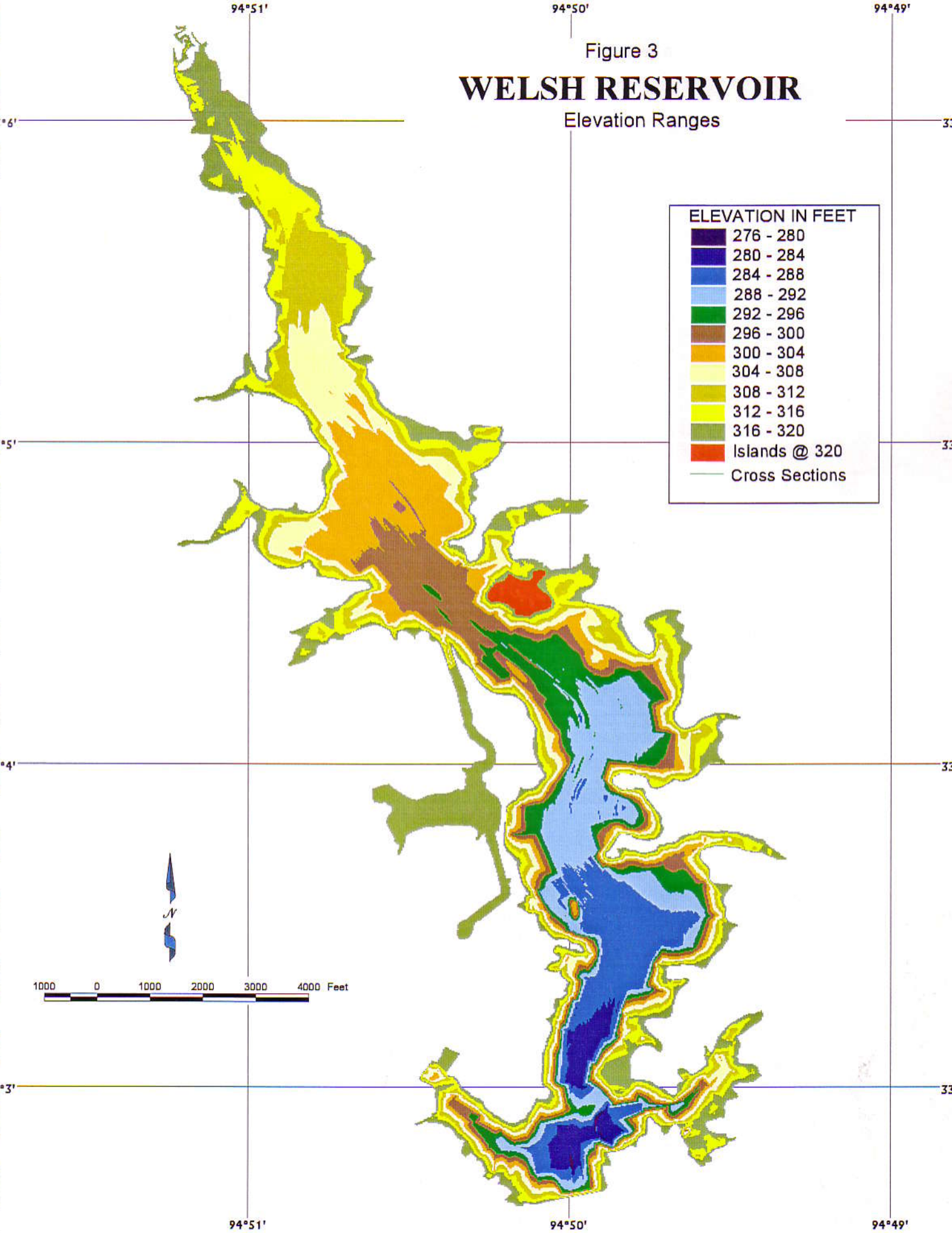


TWDB Survey November 2001

Figure 3

WELSH RESERVOIR

Elevation Ranges

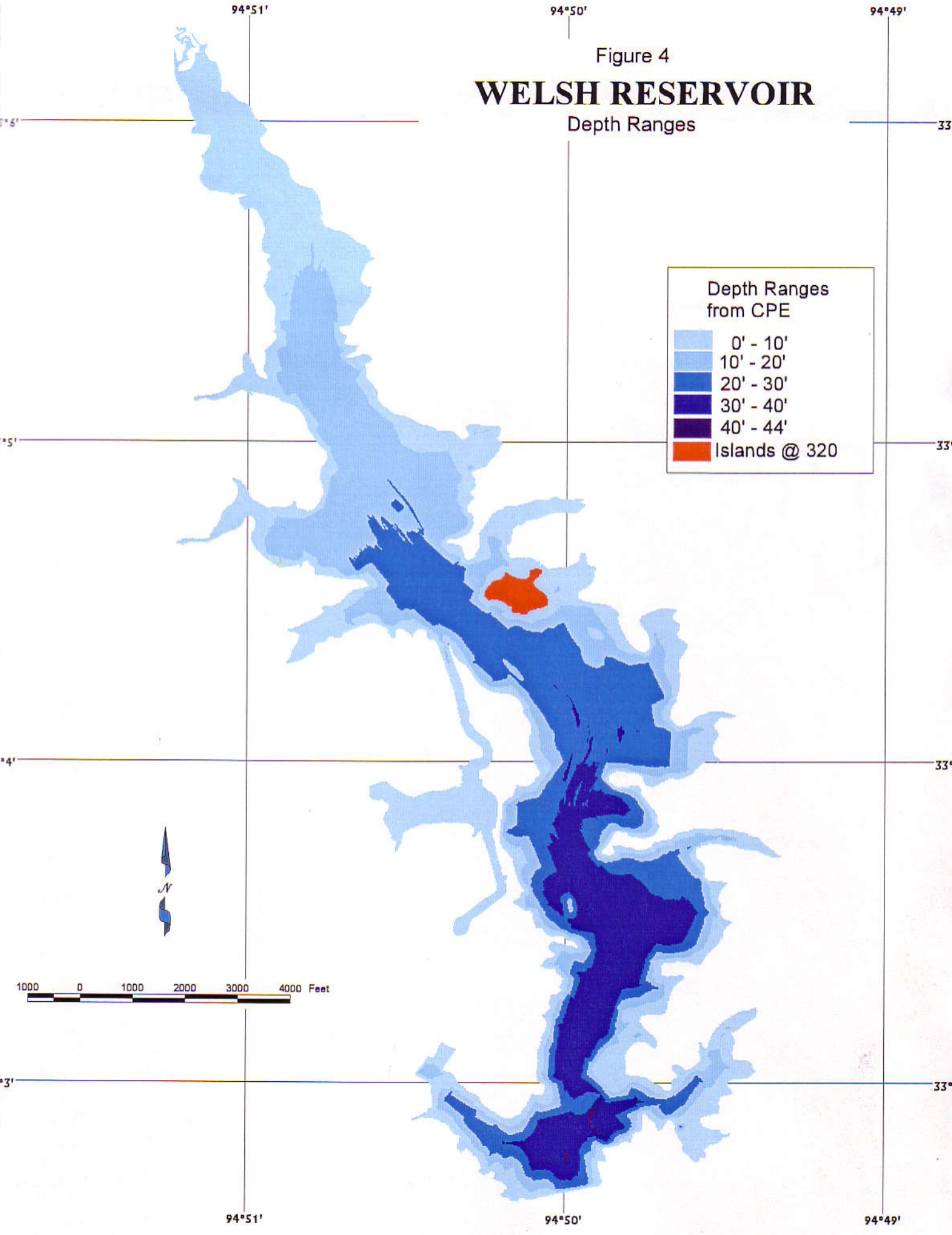


TWDB Survey November 2001

Figure 4

WELSH RESERVOIR

Depth Ranges



TWDB Survey November 2001